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METALLURGIST

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FOR ECONOMY, THRIFT, AND COST REDUCTION

B. A. Chusov

Translated from Metallurg, No. 2,
pp. 1-2, February, 1961

Much discussion of economy thrift, and cost reduction, of ways to increase labor productivity more and utilize productive resources better, has taken place at economic conferences held at all the Metallurgical enterprises of the Moscow region. People of various trades and professions (steel smelters, rolling mill operators, refractory makers, economists, bookkeepers, party and trade union workers) have taken an active part in the work of these conferences. After carefully analyzing the activity of their enterprises they have posted the results of the competition for fulfilment of the resolutions of the July Plenum of the Central Committee of the Communist Party of the Soviet Union and the Fifth Plenum of All-Union Central Council of Trade Unions.

These results showed how the consciousness of the Soviet peoples has grown all told in only one year. There are already about 30,000 workers and specialists striving for the honorary titles of Collectives and Shock-Workers of Communist Labor. Ninety percent of all the metallurgists in the enterprises of the Moscow Council of National Economy have engaged in the struggle for an honorary title. Among them are the "Elektrostal'," the Lepse, the Podol'sk chemical-metallurgical, the Shchelkovskii plate rolling mill plants, and others.

During the period of preparation and holding of economic conferences, 278 suggestions were adopted; the economic effect of their introduction will amount to more than 2.24 million rubles per year. (The 1961 scale of prices is used in this article.)

In ten months of 1960 the "Electrostal'" factory increased labor productivity by 3.7% instead of 2% provided for by the plan. It was here that smelters A. V. Sergushin, N. I. Morozov, S. G. Dubov, P. I. Gureev and others began to heat steel at below the average limits of alloy contents. The teams led by them produced about 200,000 rubles of savings in the use of tungsten and vanadium. Steelworkers in other furnaces and mills of the factory have followed their lead. The advanced experience of the electrosteelmakers has been transmitted to the metallurgical enterprises of the region and of the Union.

The initiators of this patriotic movement have been granted honorary citations by the All-Union Central Council of Trade Unions, as well as being the recipients of state bonuses.

In ten months of 1960 the factory saved 834,000 rubles and 4,181,600 kilowatt hours of electrical energy.

Many teams and sections of the factory have already reached the level of labor productivity set for 1965. Steel Works No. 3 will produce as much steel this year as was planned for 1965.

In accordance with the resolution of the economic conference, every measure in the mechanization and automation of the productive processes at the "Electrostal'" factory will be included in the plan only after careful determination of its economic effectiveness.

Idle time of equipment of all the reduction plants has been considerably diminished and the roughing and grinding staffs have been combined.

To reduce costs further and save alloys, including nickel, the conference decided to examine the standards of consumption of charge materials. In the fourth quarter of 1960 the norms of utilization of scrap of the same type were already increased, not to 10 as contemplated by the plan, but to 12 experimental types.

To study and introduce the latest attainments of Soviet and world science and technique, a factory University of Technical Progress has been organized in the city of Electrostal', at which more than 300 workers and engineering-technicians are studying. The university is setting itself the task of directing the attention of its audience to the solution of problems in the redesign of the factory and to the introduction of the latest attainments of domestic and foreign metallurgy. Studying at the University of Technical Progress promotes the development of technical thinking at the factory.

The activity of efficiency workers and inventors has increased considerably: 1040 suggestions have been made in ten months of 1960, leading to savings of 390,000 rubles. Complex teams of efficiency workers have been formed in the factory and have introduced many valuable suggestions.

The team of efficiency workers consisting of V. N. Butskii, V. G. Pereverzev, A. M. Artamanov and others has worked out the design of a machine for mechanized cleaning of sheet bars. The machine has been built and is now being mastered.

Factory efficiency workers V. V. Tokarev, K. S. Tolstopyatov, L. P. Okunev (of the KIP works) have developed and introduced a design of regulators for the power supply of automatic instruments controlling the temperature of the furnaces. Rolling mill operators A. F. Izotov, A. A. Korolev, and P. G. Sokolov of Works No. 2 have created an aggregate for automatic welding, under a layer of flux, of bimetallic sheet bars, providing an annual saving of 11,000 rubles. In the same plant, efficiency workers Comrades Patepalov, Peshakov, Sergeev, Gusev, and Golovanov designed and introduced into production a single-bead furnace for the heat-treatment of micron sizes. At the present time a new aggregate, a six-bead furnace, is being built on the basis of the experience obtained.

A team of efficiency workers made up of Ya. S. Shvartsbart, V. S. Lun'kov, N. I. Popov, Yu. P. Nikol'skii, Ya. M. Mininberg, Yu. P. Karasev, and B. A. Chernikevich has suggested and introduced increased weights of ÉI636 and ÉN29K18 alloys and others to raise the productivity of the hammers and Lauth mill, increasing the annual yield and shortening the cycle of production of plate.

It has been calculated preliminarily that as a result of introducing this measure the annual saving will be more than 100,000 rubles.

The staff of the planning and design section of the factory has been reinforced with young specialists and has grown from 28 to 42.

An office of mechanization and automation, consisting of four men, has been organized in the technical section, and a laboratory of automation and mechanization in the KIP works and automatics.

To attract factory workers to more active participation in solving the problems of mechanization, announcement was made in 1960 of a competition for the best plan for the mechanization of the transportation of hot metal from the hammers of the forges to the rolls.

A number of measures have been carried out in the mechanization and automation of productive processes.

In ten months of 1960 a team of the forge-press fulfilled the state plan by 106.5%, and in so doing saved 177,000 rubles in costs, 600 tons of fuel oil, and 306,000 kilowatt hours of electrical energy.

At the Lepse Solnechnogorsk plant the engineering and technical workers, jointly with innovators and scientists, in fulfilling the resolution of the economic conference at the factory, have developed a plan for the redesign of individual productive units.

The factory collective, jointly with a number of organizations, has designed and mastered the production of special housings for the filters of motors; as a result of this there has been a saving of five tons of bronze per year.

With the active participation of the teams and shock-workers of communist labor, the collective of the factory attained a massive output of tinplated Armco steel for detonator leads, in so doing creating a universal continuous automatic line. The introduction of this measure will save 125 tons of red copper ore per year and release three workers for utilization in other work, with an annual payroll saving of 2800 rubles.

The collective of this factory on the eve of the 43rd anniversary of the Great October Socialist Revolution pledged increases and entered the competition for the title of "Factory of Communist Labor".

The results of the economic conferences which have been held are evidenced by an increase in the mass economic operations in the Moscow region and are revealing a great possibility of using resources to increase labor productivity and accelerate the rate of mechanization, the automation of productive process, and reinforcement of the struggle for improvement in the qualitative indices in all sections of the enterprise's operations.

Economic conferences, first held last year, have shown that they are one of the most important forms of attracting workers to the struggle for technical progress.

THE SCREENING OF HOT SINTER

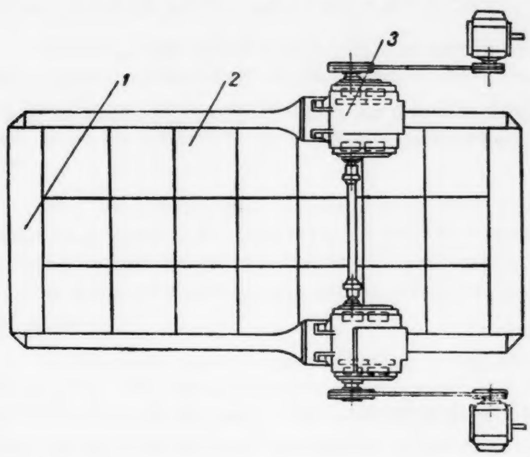
L. M. Rudakov, Chief of the Sintering Group TZL, Voroshilov Plant
I. I. Gorstein, Technical Science Candidate, Voroshilov Pyrometallurgical Institute

Translated from Metallurg, No. 2
pp. 3-4, February, 1961

In many sintering plants in the Soviet Union hot sinter is fed onto stationary-grate screens ; consequently, a significant quantity of fines remains in the product sinter while the clearance between the grates is small, but as the clearance increases much of the sinter enters the tailings.

In order to screen out the fines more effectively in some sintering plants, the Cherepovets and YuGOK in particular, the sinter is fed first into a stationary screen and then onto a vibrating screen which is set up after the cooler (Cherepovets) or under the stationary screen (YuGOK).

In the Alchev sintering plant hot sinter is separated only on self-reciprocating screens of the type designed by the Leningrad Institute "Mechanobr". The screen is mounted horizontally on steel brackets under a single-roll crusher (see Figure). The frame is made of two vertical walls, П-shaped in cross section and joined below with pipe crossties. At the top of each side a platform on which to mount the self-reciprocating vibrators is provided. The screen is made of single plates, spaced to provide longitudinal openings which widen downward. The self-reciprocating mechanism has two vibrators, each of which is run by a separate electric motor through a Texrope drive. In order to synchronize their operation, the vibrators are joined by an extended coupling which allows a brief interruption of either motor. Each vibrator consists of a steel housing in which two shafts with eccentrics are geared together and mounted in roller bearings. The vibrators have circulating-fluid lubrication.



Self-reciprocating screen: 1)Frame ; 2) grates ; 3) vibrator.

Two screens are mounted one after the other on each sintering machine. The first screen is intended to separate out the tailings, and the second-to screen off the bed. Inasmuch as the bed conveyor does not operate continuously, both screens separate out tailings.

During the early period of operation of the sinter plant, it became evident that the self-reciprocating screens had certain shortcomings which lowered their productivity and necessitated long shutdowns (up to 7% of total shutdowns) of the sintering machines.

Screen characteristics are given below :

Screening surface, m^2	10 (2× 5 m)
Speed of eccentrics, rpm	650
Amplitude of vibration, mm	5
Number of electric motors	2
Power rating of electric motors, kw	10
Speed of electric motors, rpm	1000

These shortcomings included the following:

1. The screens were operated under unfavorable conditions, since pieces of sinter (up to 400 mm in size) fell from a height of 4 m onto the grating surface.

2. Under the maximum screen load with the depth of the sinter layer reaching 500 mm, the output of the screen decreased. Shutdowns occured as a consequence of the sharp gain in inertial mass and the slipping of the belt.

3. The possibility of continuous straining of the belt had not been foreseen.

4. The brackets broke.

5. The bracing of the grating plates did not hold.

6. The cooling system of the vibrators was insufficient.

In order to eliminate these shortcomings, the workers in the Voroshilov and Parchomenko plants modified the screen design. One crossbrace was removed allowing the screen to take a layer of sinter up to 500 mm. The diameter of the pulley on the vibrator was decreased permitting an increase in speed from 650 to 700 rpm. In order to decrease belt slippage, one-sheave pulleys were replaced by two-sheave pulleys. The motors of the vibrators were mounted on a carriage to permit regulation of the tension in the belt.

The grating plates are now welded rather than bolted to the sides of the frame, and the design of the feed hoppers has been altered so as to cushion the impact of the falling pieces of sinter. The design of the brackets has also been changed, and the capacity of the cooling system of the vibrators has been increased by using water.

These modifications have permitted the hourly screen output to be increased from 60-70 to 150 tons of sinter, and shutdowns of the sinter plant have been decreased 4-5%.

Self-reciprocating screens with grates spaced 8 mm apart and a 5-5.5% open-grate surface provide sufficiently effective screening of the sinter and allow the recovery of a satisfactory product. The content of fines less than 5 mm in the screened sinter is 2.5-3.5%. The size distribution of the tailings from beneath the screen is given below.

Fraction, mm	0-5	3-5	5-8	8-10	10-12
Content, %	40.6	17.8	40.4	1.1	0.1

Recovery in the tails is 25-30%. Self-reciprocating screens with the design modifications indicated give promising service and may be recommended for introduction onto other plants.

ERRORS IN THE REGULATION OF GAS FLOW

N. N. Chernov

Dneprodzerzhinsk Metallurgical Plant and Higher Technical School
Translated from Metallurg, No. 2
pp. 4-6, February, 1961

In the journal Metallurg No. 8, 1960, the article by A. N. Chechuro and I. L. Kolesnik, "Errors in the Regulation of Gas Flow and in the Distribution of Materials at the Mouth of the Furnace" was published. The editors received many reactions to this article from blast-furnace operators throughout the nation. With this issue we are beginning to publish these reactions.

Considering the importance of the questions touched on by A. N. Chechuro and I. L. Kolesnik, the editors invite blast-furnace operators to take part in the discussion and express their opinions.

The most important factor in the normal functioning of the blast furnace is the uniform distribution of gas flow over a cross section of the furnace. The basic cause of disruption of the normal distribution of material and gases in the furnace is usually a fluctuation in the grade of the raw material and fuel. These fluctuations change the character of the gas flow through the furnace.

The determination of the optimum relation between gas flow at the periphery and the center of the furnace is essentially a major and very complicated problem in blast-furnace smelting. For this reason, blast-furnace operators are constantly engaged in developing a method for regulating the operation of furnaces intended to decrease the deleterious consequences of fluctuations in the grade of the burden. In this regard, the article by A. N. Chechuro and I. L. Kolesnik deserves special attention.

In the Dzerzhinsk plant the ore-on-limestone method of charging was used for raising the temperature of the periphery, and limestone-on-ore for lowering it (i. e. , a charging program opposite to the one formerly recommended was used). There had been reports in the literature [1] of instances when the method of charging which was intended to open the periphery loaded it, and the method intended to load the periphery opened it. However, no explanation of this interesting phenomenon was ever given. A. N. Chechuro and I. L. Kolesnik not only explain this fact for the first time, but also introduce a very practical matter. They maintain that the lowest temperature of peripheral gases is observed where the flow of gases and materials reaches its maximum intensity, and the highest temperature where the burden temporarily stops or moves but slowly.

In the author's opinion, evidence of the fast movement of raw materials in regions of intensive gas flow is provided by the appearance of dark pieces of unreacted materials at the tuyeres after channels have begun to develop. It follows that a channel is not characterized by an increase in temperature in the region where it appears, but rather by a temperature decrease.

We consider this to be mistaken. A channel represents a local, highly loosened portion of the burden with an abnormally high gas-permeability toward which rush large quantities of gas at a sharply increased velocity. In the blast-furnace, gas, aside from its function as a reducing agent, serves as a conveyor of heat from the lower horizons where the fuel is gasified to the upper horizons. Accordingly, the temperature will be a maximum in the region through which a large amount of gas flows.

As for the appearance of dark pieces of material at the tuyeres in the region where a channel opens, this is not unequivocal evidence of the intense movement of raw materials at this location. Our studies on a model of the blast-furnace have indicated that in the region of a channel the burden is in a half-suspended, loose condition. Fines are completely blown out, and larger particles slowly alter their position, turning about one of their axes.

The active forces here, instead of being forces of friction between individual particles, are the smaller frictional forces between the charge and the gas. As a result, individual particles of the charge with high specific gravity pass from the mouth to the hearth of the furnace too quickly to be completely reduced or even well heated. In other words, only those pieces will move faster which fall directly onto the location of a channel while charging the furnace.

If an intense mass movement of material capable of lowering the temperature of the gas, together with an increased gas velocity, were observed in the region of a channel, a decrease in the CO_2 content of the gas would not necessarily be registered. The last circumstance is only an indication that too much gas is flowing in the region of the channel, while the intensity of movement of raw materials is insufficient.

As far as the inverse effect of the charging methods, ore-on-limestone, is concerned, we fully agree that these methods may, respectively, relieve or change the periphery. However, this cannot be explained by postulating that due to the different velocities of material flow at the walls a low wall temperature will accompany peripheral flow of gases, and a high temperature, central flow. The reason for this effect is that the column of charge is constantly in motion, and its configuration on the charging level changes. As a result of this, different conditions determining the distribution of materials during charging are created at the mouth.

If the crater is shallow with a gently sloping profile (rapid movement of material on the periphery), the ore will naturally have less tendency to spread toward the axis of the furnace than if it is deep with a steep profile. If a very deep crater exists, the method of charging ore first will accordingly relieve the periphery, since the ore charged onto the steep slope from the large bell-hopper has a greater tendency toward the axis of the mouth.

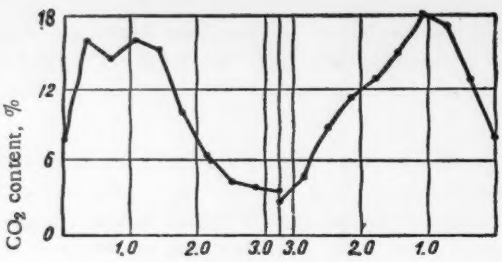


Fig. 1. Radial gas distribution in the shaft with a strongly developed central stream; March 5,1960.

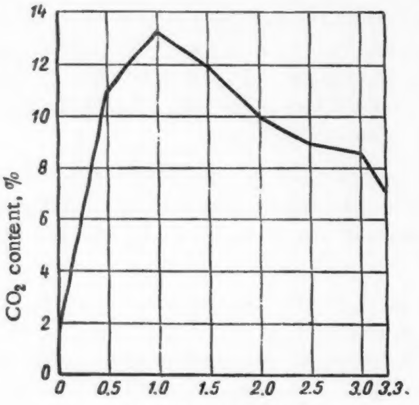


Fig. 2. Radial gas distribution in the shaft with a peripheral stream; April 20, 1960.

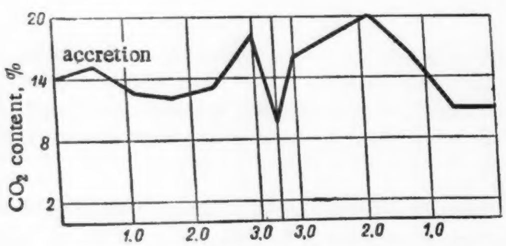


Fig. 3. Radial gas distribution in the shaft with an accretion present.

This in turn will lead to a loosening of the column of material on the periphery and a corresponding redistribution of the flow of gases through the burden.

This explanation is fully confirmed by the example given by A. N. Chechuro and I. L. Kolesnik of the performance of the furnaces on 5 and 25 March, 1960. In the Dzershinsk plant, air is blown into the blast-furnaces at a rate of 2.25-2.35 m^3/min for each cubic meter of useful volume. This leads to the formation of "pipes" of ineffective gases at the center and a reduction in peripheral flow (Fig. 1).

While in the plant "Zaporozhstal' " of the Magnitogorsk and Kuznetsk combine the furnaces operate with a wall temperature below the guard ring of 800-870°, the corresponding temperature in the Dzerzhinsk plant is usually only 620-700°. A comparison of the speeds of charge descent with the CO_2 content of the gas shows that, in the majority of cases, the greater the speed of descent, the lower the concentration of CO_2 and, consequently, the faster the development of a gas stream. The decreased content of CO_2 at the center indicates the rapid movement of material there and, accordingly,a deep crater. Its deepening was promoted also by the increase in gas pressure at the mouth from 0.8 to 1.2 atm.

The deep crater at the center was also the basic cause of the unusual effect of the charging method. This would not have happened if the distribution of gas had been as indicated in Fig. 2.

In order to obtain more even and steady operation of the blast-furnace, the charging methods should not be kept fixed,but should be varied according to the changes in the distribution of material at the mouth and the flow of gas in the shaft. The necessity for changing the order of charging and the direction of the change may be estimated from the composition of the gases along a diameter of the furnace and from the temperature of the wall below the charging level.

Finally, A. N. Chechuro and I. L. Kolesnik assert that the highest temperature of peripheral gases in the blast-furnace is explained by congestion or slow movement of the burden. If this were so, then the highest temperature would occur above an accretion formed in the furnace, because here there would be practically no movement of the charge, Actually, the CO_2 content is, as a rule, increased above an accretion indicating a relatively low temperature.

Observations on the performance of the blast-furnaces in the Dzerzhinsk plant have shown that the temperature of the peripheral gases decreases with increasing CO_2 content. The temperature change of the walls lags somewhat behind the change in CO_2 content due to the low conductivity of the refraçtory bricks.

Therefore, the temperature will be high where the flow of gas is large. An intense flow of gas always accompanies maximum gas-permeability. If movement of the burden is sluggish or obstructed, permeability will be low,which means poor preheating .

It would be possible to explain the heat effects in an obstructed region as a result of heat transfer by conductivity. However, this explanation is unconvincing, since the transfer of heat in this manner requires too much time.

THE TRIPLE BELL HOPPER

N. K. Borodenchik, A. I. Dikalov, D. A. Storozhik, and A. M. Khmara

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Translated from Metallurg, No. 2
pp. 7-11, February, 1961

In June, 1960,a triple bell hopper * was installed on one of the blast-furnaces in the Zaporozhstal' Plant. During the planning period all variations of the triple bell hopper were investigated, and the experience of many years in increasing the durability of the double bell hopper was reviewed.

The installation of the new hopper was intended to obviate replacement of the feeding apparatus (the large bell and its housing), thus eliminating shut downs between major overhauls of furnaces of the second category. For this purpose, in the following design the gas pressure above the big bell during the entire period of its operation is maintained equal or near to the pressure at the mouth of the blast-furnace. In this manner, the big bell and its housing are freed from pressure drops; that is, it ceases to function as a gas seal and serves only as a distributing device. The roll of the gas seal is filled by two bells (the upper and middle). Both small bells can be replaced in parallel.

Adaptation of the triple bell hopper was made possible by rebuilding the furnace on which it is mounted: Tha capacity of the furnace was increased; the height of the mouth was raised approximately 5 m, and the truss of the skip elevator was lengthened accordingly.

Thc triple bell hopper works as follows. Material from the skip (Fig. 1) falls through the receiving hopper into a hopper with a rotating distributor which is closed below by a small bell. To discharge material from the hopper into the upper-bell chamber, it is necessary to lower the upper bell by opening an exhaust valve (Fig. 2). The intake valve is closed during this time. The charge pours off the upper onto the middle bell and fills the hopper. After the exhaust valve of the upper bell closes and the intake valve opens, the pressure in the upper and lower interbell chambers become equal. The middle bell opens, and the charge from the upper interbell chamber falls into the lower. As soon as a full load (or a half-load) accumulates on the large bell, it opens (the middle bell must the while be closed), and the charge falls into the furnace. The capacity of the upper interbell chamber was calculated on the basis of receiving one skip of charge ($10m^3$), and the capacity of the lower space-a full load ($42m^3$).

The charge distributor with hydraulic seal designed by K. P. Gulyanitskii† is driven by two electric motors running on the same differential reducing gear. Consequently, it can be operated under both continuous and periodic running conditions.

The distributor was not operated under fast running conditions, since the advantages of such a schedule are doubtful when the furnace operates with a relatively uniform burden. Moreover, this type of schedule is likely to cause vibrations and fractures in the charging mechanism. The ratio of the height of the hopper to the diameter is 2.44. This,together with triple spilling (twice through hoppers 1820 mm in diameter),provides an even distribu-

* The hopper was designed by the planning group in the department under the head machanic of the Zaporozhstal' Plant. It was made in the mechanical repair.

† Stal' No. 4 (1956).

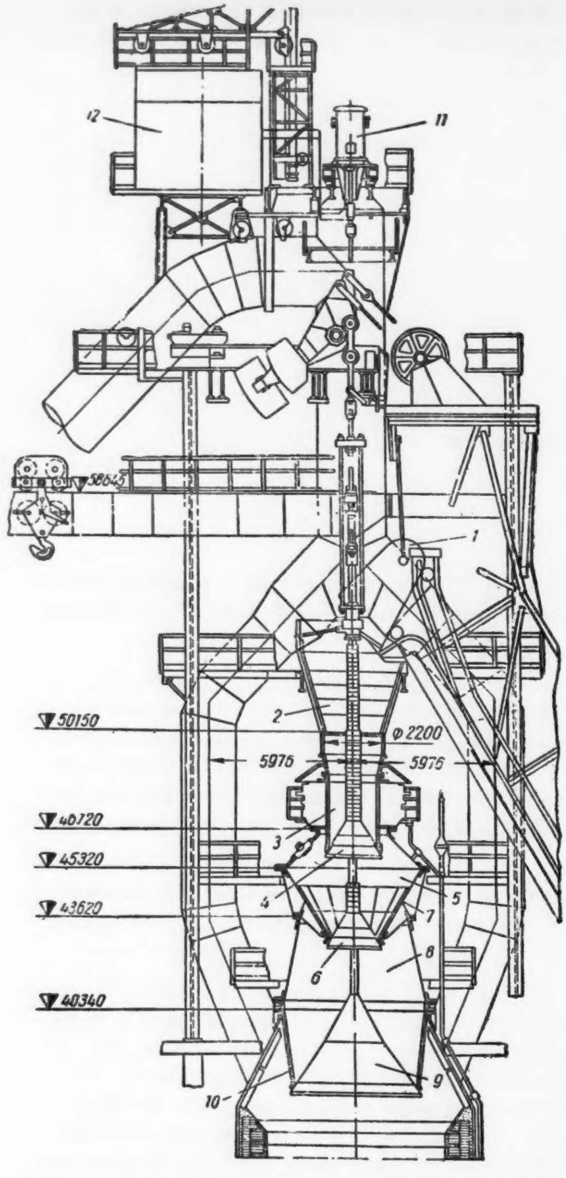

Fig. 1. A triple bell hopper on the mouth of the blast-furnace. 1) Skip ; 2) receiving hopper ; 3) hopper for charge of distribution ; 4) upper small bell ; 5) upper (small) interbell chamber ; 6) lower small bell ; 7) middle bell hopper ; 8) lower (large) interbell chamber ; 9) large bell ; 10) housing of the large bell ; 11) hydraulic cylinder for raising and lowering the middle bell ; 12) compartment for the hydraulic station.

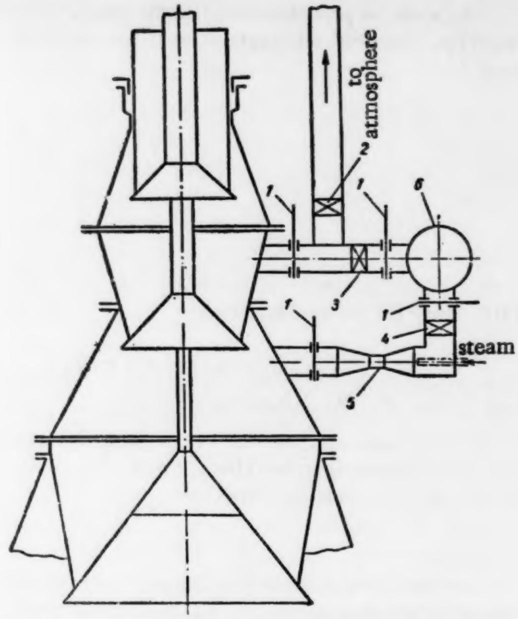

Fig. 2. Schematic design of the gas pipes and regulating valves. 1) Slide plates for blocking off valves during repairs ; 2) exhaust valve ;3) intake valve for the upper interbell space ; 4) intake valve for the lower interbell space ; 5) steam injector ; 6) pipe for partially cleaned gas from the high-pressure scrubber.

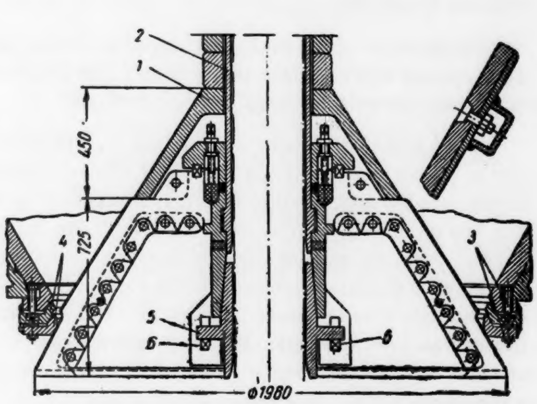

Fig. 3. The small bell and hopper with the one-piece, replaceable contactring assembly. Upper right-bracing of the guard plate. 1) Guard cap ; 2) shaft of the small bell ; 3)tie bolts with nuts ; 4) replaceable contact rings ; 5) shaft collar ; 6) wedges.

tion of the burden around the mouth. It is to be noted that the excellent, even distribution of the burden is accompanied by serious difficulty in interpreting the periodic operation of the distributor, since the degree of inhomogeneity of the charge in the hopper is small and is ironed out by spilling. Segregation of materials is weakly indicated.

It must be pointed out that the technological side of charging the furnace with a triple bell hopper needs investigation.

The upper small bell and the large bell are run from the hoist and reciprocating lever of the type KP 1-85; the middle bell is raised and lowered by means of a hydraulic drive.

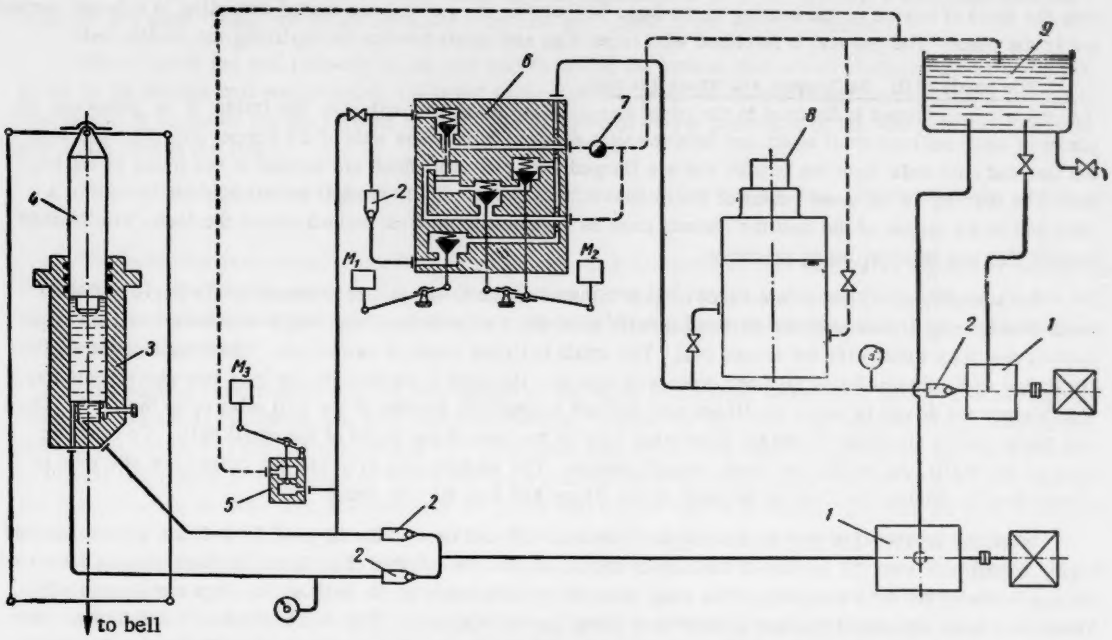

Fig. 4. Schematic Diagram of the hydraulic driving gear. Pressure mains are designated by full lines, overflow pipes by broken lines. 1) Pumps; 2) return valves; 3)master cylinder; 4) piston; 5) emergency valve; 6) control chamber; 7) throttle; 8) safety valve model BG-52-14; 9) oil reservoir; M_1, M_2, M3-magnets.

This particular arrangement of gears was influenced by the facts that the concept of the hydraulic drive was new, there had been no experience in the use of hydraulic mechanisms on the mouth of the blast-furnace, and in case of failure of the hydraulic drive it would have been possible to open the middle bell and operate as a double bell hopper.

To ensure maximum durability of the small bells, the gas fed into the space above the large bell comes from high-pressure scrubber rather than from the furnace pipes. This gas contains practically no abrasive particles, and its temperature is considerably lower than the temperature of the gas in the upper part of the furnace. Feeding partially cleaned gas into the upper and lower interbell chambers does not, however, settle the problem of dust elimination from the gas, since a great deal of dust is created when the charge is spilled from the bells. A steam-jet injector has been installed for the purpose of creating a pressure in the lower interbell chamber 0.02-0.05 atm higher than the pressure in the furnace. The valve feeding gas into the lower interbell chamber is closed when the large bell is working. This, together with the installation of the injector, protects the pipe feeding gas into the lower-bell chamber from contamination with dust from the mouth of the furnace.

Changes in construction worked out by the plant have been introduced in the design of a new apparatus: one-piece, removable contact rings are adapted on the hopper with the rotating charge distributor ‡, the angle between the contact surfaces of the bells and hoppers is increased to 62°, the housing of the big bell is made with two flanges.

A description of the most important assemblies of the triple bell apparatus is given below.

The large bell, its housing and lower gas seal.

Considering that the bell and housing must operate without renewing for 4-5 years and during this time handle an

‡ Metallurg No. 9 (1959).

enormous quantity of charge, a layer of sintered-powered rod was fused onto the entire working surface (thickness of the deposit is 8 mm); the housing of the large bell was coated to a height of 800 mm from the lower edge (thickness of the deposit is 5 mm).

In addition to the sintered-powder rod, sormite was welded onto the contact surface. No appreciable wear of the working or contact surface was observed after a year of service. The openings for inserting gauges to measure the level of charge in the housing of the large bell and in the gas seal are sealed according to a design worked out in the plant. The gas seal is furnished with inspection and repair hatches for replacing the middle bell.

The small bells, the hoppers, and upper gas seal.
The middle bell hopper is fastened to the upper flange of the lower gas seal. On the inside it is protected by plates of wear-resistant steel which are fastened with through-bolts to the wall of the hopper (Fig. 3). The nuts are screwed onto bolts from the outside and are flanged with end caps which are welded to the frame of the hopper. The bracing on the guard plates of the middle hopper is accordingly brought outwards, since in case of a blow-out in the region of the bolt the furnace must be shutdown to uncover and eliminate the leak; with outside bracing this can be done during operation.

An assembly of replaceable contact rings is fastened in the lower part of the hopper. To begin with, the lower contact ring is used with the first small bell; after this pair wears out, the ring is sheared off and the upper contact ring then works with the second bell. The small bells are made of two halves. Their seats of the shaft are sealed with asbestos luting fastened down with screws. The seal is covered on top by a two-piece guard cap. Two wedges are driven between the flange and the bell to preclude turning of the bell relative to the shaft. The two-piece collars are fitted by means of beveled ends to the bore of the shafts of the small bells. To decrease wear on the shafts, the collars are made smooth mounts. The wedges used to install the collars are also used in dismantling by driving them out of the hole below flange and into the one above.

When the replaceable ring on the hopper is sheared offf, the nuts on the stays of the bell are adjusted accordingly. Experience with the service of the hopper has shown that the number of replaceable rings must be increased; the gap between the cross members of the stays must allow adjustment of the bells as the rings are sheared off. There have been repeated instances of blow-outs along the vertical joint. This has been observed to happen particularly with the small bells of the triple bell assembly. Thus, after having served for about 8 months, the first bells were worn out along the contact surface. The next upper bell was replaced within 4 months after installation due to leaks along the joint. In order to curtail the continual changing of the small bells, it is intended to alter this joint by mounting one-piece, replaceable contact rings on the small bell (in anology to the housing).

The upper gas seal is provided with inspection and repair hatches; these last are used when replacing the upper small bell.

The sealing of the gap between the shafts of the bells is very important to the operation of the triple bell assemby, because the shaft of the middle bell is made of pipe, and the sealing is constantly subjected to full pressure drops. The gasket seals used during the first months of operation did not provide hermatic sealings of the gaps, and this led to heavy wear of the shaft of the large bell. To restore the shaft in the worn places, a special contrivance was machined; this two-piece "shirt" was welded on and ground-off flush with the casing of the shaft. At the same time, both seals between the shafts were replaced by a new type designed at the plant. The gap was sealed with gaskets of two types: above, the gasket "split", well recommended by many years of service on charge distributors with a hydraulic seal, and below, the gasket "rational". Steam and oil are brought to the seal. To prevent overheating of the gasket seal during the burning of gases in the receiving hopper, its housing is water-cooled. A standard bushing is set in the bearing of the upper bell. The seal works very well and is being introduced on the other blast-furnaces on the plant.

Regulating valve. In order to equalize pressures in the upper interbell chamber, the plant has used valves of its own design (matched with a built-in electric drive). As usual, two series of such valves are installed. Valves with built-in electric drive were also used for feeding gas into the lower interbell chamber. However, experience with these valves under a gas pressure of 1.5 atm has shown that their parts (the rods and casings of the small valves) quickly wear out. This is caused by eddying, sharp reversals of the gas stream, and changes in the flow crosssection. The valve rod is situated in the path of the flow. Attempts to increase the durability of these parts with various welds were unsuccessful. The plant is now working on an improved design for making the valves.

The hydraulic gear. The hydraulic gear (Fig. 4) is comprised of a master cylinder and piston and two identical independent pumping stations which are installed in a special compartment on the blast-furnace. One station is operated at a time, and the other is held in reserve. The system employs radial-piston pumps model NPM-713-B of 200 liters/min capacity at a maximum pressure of 100 atm. These pumps serve to rapidly raise the bell. To finish bringing the bell into the upper position (at the end of its closing) and tightening it to the housing, two eccentric pumps model N-401 are used, with capacities of 18 liters/min and a maximum pressure rating of 300 atm. These pumps are intended to reverse the valves in the control chamber.

When closing the bell (drawing in the bell and switching the system then set on discharge of oil to the reservoir as the middle bell was lowered), oil is fed to the cylinder from the N-401 pumps by the control chamber. The circuit is regulated for the pressure in the mains of 150 atm during tightening of the bell; the pressure is 50 atm while raising the bell.

The two pumping stations are separated and work independently of one another. The system uses spindle oil, type AU.

The hydraulic gear assembly needs to be perfected. The control chambers with valve regulation require the installation of cups; the chambers quickly get out of order (period of service is one monthe). The valves are regulated by cumbersome electromagnets of the crane model KMP-4. These were replaced by gate valves with small electromagnets.

The working conditions during the duty period of the triple bell hopper were rather harsh. The average furnace temperature at the mouth was 460°, and it sometimes climbed to 600-700°; the amount of dust carried out (100 kg per ton of ore) and the gas pressure (1.4 atm) were also large. The lack of experience and the presence of several limitations in the design of individual units occasioned a relatively large number of shutdowns during the first period in service. The adaptation of the triple bell hopper can be economically justified only if the duty life of the big bell and its housing, and the shafts and housings of all three bells can be increased to about 4-5 years without replacing, i. e. to the time between major overhauls of the furnaces of the second category. If even one of these parts must be changed, the entire assembly must be taken apart which requires a great deal of time and cancels the advantages of using the new apparatus. Excessive overloading of the three bell hopper loads to additional comminution of the charge; however, this effect is not pronounced, and the furnace has a very satisfactory ratio of working volume to daily output (0.68–0.70).

Widespread adoption of the three bell assemblies should, in our opinion, begin only if another approach to increasing the durability of the common feeding mechanisms cannot be found, and then, only after a complete reworking of the design of the three bell assemblies.

The use of the hydraulic gear for raising and lowering bells is advantageous. The essential plan of the hydraulic gear is not appreciably complicated by transferring two bells to it, and therefore, we consider it possible to install hydraulic gears on ordinary double bell hoppers.

DUST EXTRACTION IN SINTERING PLANT FUME CHIMNEYS

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Power Engineer at the Sintering Plant of the "Zaporozhstal' " Factory.
Translated from Metallurg, No. 2
pp. 11-13, February, 1961

One of the principal current sources of dust in the vicinity of a sintering plant is the fume chimney of the fine-returns drum coolers. At plants where the fine returns are used for heating the charge, a considerable quantity of dust is discharged into the atmosphere through the fume chimneys of the primary mixers, in which the fine returns are mixed with the charge.

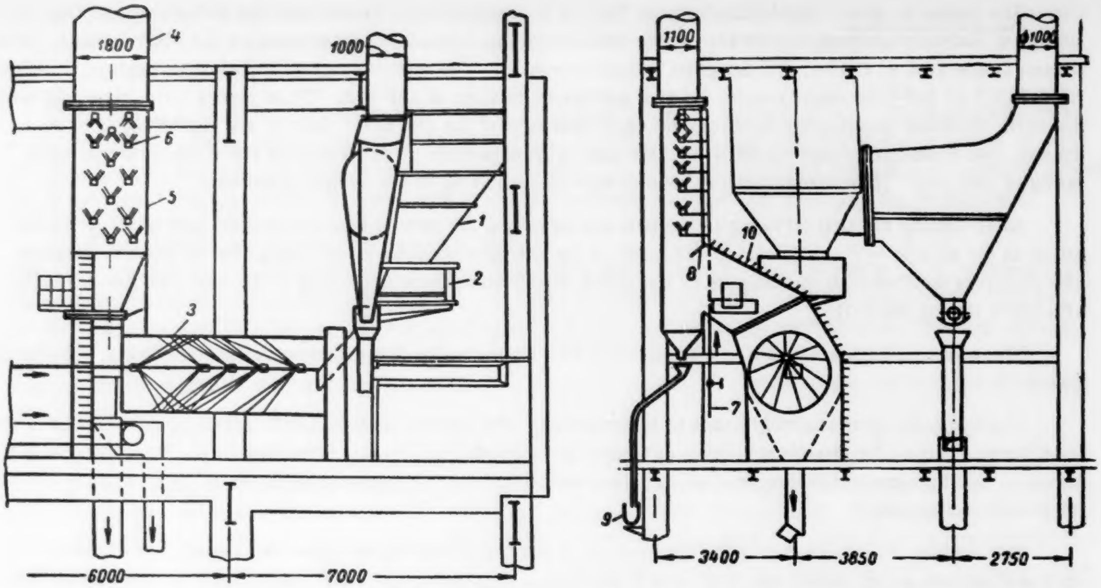

Fig. 1. Diagram of two-stage dust extraction. 1) Fine returns hopper; 2) rotary table feeder; 3) drum cooler; 4) fume chimney; 5) scrubber; 6) atomizer; 7) water supply pipe to scrubber atomizers; 8) baffle; 9) collecting trough for sludge from all scrubbers; 10) connecting section.

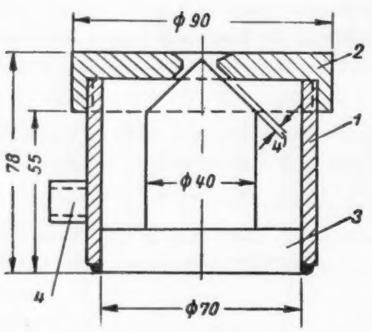

Fig. 2. Atomizer. 1) Casing; 2) cover; 3) needle; 4) connection.

At the sintering plant of the "Zaporozhstal' " factory, the fine returns from the hopper, in which individual particles showed temperatures of 700-800° C, were fed by a rotary feed table to the drum coolers, where they were cooled to a temperature of 80-90° C by sprinklers. The stream produced in the coolers escaped to the atmosphere through natural-draft chimneys, letting out 3 m above the highest part of the sintering plant building. This exhaust ensured the complete removal of steam from the coolers; but at the same time, large quantities of dust were discharged into the atmosphere by the fume chimneys.

According to measurements made in 1960, the quantity of dust discharged into the atmosphere by one fume chimney was 600 kg (for a sintering machine output of 110 t/hr). This caused intense dustiness of the air in the vicinity of the sintering plant, covering the roofs and ground with dust and putting steel constructions and equipment prematurely out of commission. The dust also found its way into the working premises, so that much labor was utilized in its removal. In the summer seasons, the dustiness of the air in the precincts of the plant exceeded the normal by several times; and every month there were 200 to 250 cases of persons working near the sintering plant having their eyes affected by the dust.

In 1956, at the Dzerzhinskii sintering plant, a start was made in extracting the dust from the fume chimneys of the drum coolers by connecting the chimneys to the sintering machine casings in the neighborhood of the 10th or 11th suction boxes. In 1958-1959, this method was tried out at the sintering plant of the "Zaporozhstal' " factory and elsewhere, but was not adopted for the following reasons:

1. The fume-chimney draft was impaired, causing steam and dust to be forced out from under the sintering machine casing and from the drum cooler.

2. Some of the dust found its way into the top layer of the sinter and was sent into the atmosphere when the sinter was discharged into the hopper.

3. The quality of the sinter was impaired, since some of the dust found its way into the final sinter.

In 1959-1960, a new two-stage method of extracting dust from the natural-draft chimneys of fine returns drum coolers was developed and adopted at the "Zaporozhstal'" factory (Fig. 1).

In the first cleaning stage, the dust is wetted by atomizers, and in the second stage it is extracted in scrubbers of special design mounted inside the fume chimneys.

The fine returns from the hopper are fed continuously by a table feeded to the drum cooler containing a 2-in. diameter pipe with welded-on, $\frac{1}{2}$-in. diameter steel sockets into which are screwed 7 atomizers with 18 mm diameter nozzles. The sprays from six of the atomizers are directed along the path of movement of the fine returns, while one atomizer spray is directed contrary to this movement. Figure 2 shows the construction of an atomizer.

When the fine returns are wetted by this method, a curtain of water is formed which helps to settle 25-30% of the dust in the drum cooler. At the same time, cooling of the fine returns is better than when sprinklers are used, the water consumption being the same (8-10 m^3/hr at a pressure of 2.5-3 atm gage pressure).

The steam formed during the cooling of the returns, which together with the dust amounts to 40,000 m^3/hr, passes by natural draft along a connecting section to the scrubber where, by means of atomizers of the same design as those in the cooler, 64-69% of the dust is extracted and flows away with the water (sludge) through a sludge pipe to a collecting trough and then to the settling tank of the plant. The sludge may also be thickened and reused in the process. The steam, from which the dust has been extracted, has a residual dust content of 180-250 mg/m^3 and is sent into the atmosphere through the fume chimney, or it may be used for industrial purposes.

The scrubber is an elliptical (or circular) tube in which are mounted 13 atomizers. Ten of these are directed upwardly, while the three top ones are directed downwardly. The height of the working part of the scrubber (the section in which the atomizers are mounted) is equal to three times the diameter of the fume chimney. The velocity of the steam-dust mixture in the scrubber should not exceed 5-7 m/sec. Water consumption, at a pressure of 2.5-3 atm gage, is 0.5 m^3/1000 m^3 of steam-dust mixture discharged into the atmosphere. The scrubber functions as follows: The water sprays drive the dust from the center of the current to the walls forming over the entire periphery of the working section a continuous film of water which carries off the dust. To prevent the water from running down into the drum cooler, a baffle of 5 mm thick sheet steel is fixed at an angle of 45° at the joint between connecting section and scrubber. When the scrubber is in operation, the draft in the chimney is increased somewhat, due to the ejector action of the upwardly directed atomizer sprays.

The scrubbers may also be installed in the fume chimneys of the feed tables of the fine returns hoppers and of the discharge section of the sintering machine. In new constructions of sintering plants, such scrubbers may be provided in the smoke stacks for extracting the dust from the gases before the latter are discharged into the atmosphere.

The method described for extracting dust from the fume chimneys of the fine returns drum coolers is remarkable for its high efficiency of 97-98%, the residual dust content of the gas being 180-250 mg/m^3.

The provision of the scrubbers does not involve any large capital expenditure. The cost of making and installing one scrubber in the fume chimney of the fine returns drum cooler at the sintering plant of the "Zaporozhstal'" factory was 20,000 rubles (at the 1960 prices).

ALL-UNION CONFERENCE OF BLAST-FURNACE OPERATORS AND SINTER-PLANT OPERATORS

B. N. Starshinov and V. K. Antonov

Translated from Metallurg, No. 2
pp. 13-14, February, 1961

The All-Union Conference of Blast-Furnace Operators and Sinter-Plant Operators was held at the end of October, 1960 at Magnitogorsk. Deputy Chairman of the State Scientific Technical Committee P. I. Korobov summed up in a report the work of the Soviet blast-furnace and sinter-plant operators on increasing pig iron smelting during the period since the last conference (March-April, 1957).

During the period, 17 new blast furnaces were built in the USSR. In 1957 the greatest volume of the furnace was 1386 m^3; in 1958-1960 ten blast furnaces each with a volume in excess of 1500 m^3 were started up. The world's largest blast furnace was started up at the Krivoy Rog Metallurgical Plant in December, 1960.

Presently, 75% of all Soviet blast furnaces operate at an elevated pressure and these smelt 85% of the total amount of pig iron. Operation with a gas pressure in the top to 1.5 atm and higher has been mastered at several blast furnaces. Natural gas is being used at 45 blast furnaces; this made it possible to cut down the consumption of coke by 10-17% and to increase the output of the furnaces by 2-5%. As a result of this, the saving in coke in 1959 was 1 million tons and in 1960 it was increased to 2.5 million tons.

In the period between conferences the useful output of sinter was increased from 45 to 65 million tons, and its portion in the charge from 69 to 79%.

At blast furnaces of four plants, raw limestone is completely excluded from the charge, and at the remaining furnaces its consumption has been considerably reduced as a result of increasing the basicity of the sinter (to 1.3-1.5 in the East and to 1.0-1.1 in the Ukraine) and of increasing its portion in the charge of the blast furnaces.

In 1957-1960 the blast temperature was increased from 700-900° to 900-1500° for most blast furnaces.

As the result of introducing these and certain other measures, the consumption of coke during the smelting of convertor pig iron in blast furnaces of the USSR was reduced between 1957 and 1960 from 817 to 718 kg/t of pig iron or by 12%, and in the Ukraine from 887 to 747 kg/t of pig iron or 16.8%.

In spite of introducing many innovations which made it possible to improve the indexes of blast furnace operation, as a result of the continuing decrease in the quality of the coke and the decrease in the iron content in the charge, and also the considerable idle times of the blast furnaces, the volume utilization factor 1957-1959 improved only from 0.79 to 0.77, and in the first half of 1960 to 0.75.

Better results for eight months of 1960 were attained by the blast-furnace operators of the plants Cherepovets (utilization factor, 0.57), Serov (utilization factor, 0.574), Magnitogorsk Metallurgical Combine (utilization factor 0.601), and the Zakavkazskii Plant (utilization factor 0.699). The Soviet blast-furnace operators have far outstripped the capitalistic countries in blast-furnace output.

More than 100 delegates participated in the discussion of the reports at the conference. The majority of speakers at the agglomeration section of the conference noted that for a further intensification of the sintering process, a considerable increase in the addition of burned lime is needed in the charge instead of limestone, for the purpose of which it is necessary to provide fully the sinter plants with lime-calcining devices (OPR machines, conveyors) and to increase the quality of the lime.

The participants of the conference noted that valuable experiment of the "Zaporozhstal' " Plant in increasing the sintering area of the agglomerating machines and an increase in the power of the exhausters, which made it possible to increase considerably the output of the agglomerating machines.

Great attention was devoted to perfecting the equipment of the plants and to the development of new units, particularly coolants for the sinter.

In connection with the shortcoming of coke fines, the studies on the use of heated air and oxygen in agglomeration deserve attention. These studies were carried out in 1958-1960 at the Ukraine Metals Institute and the Enakievo Plant, and recently also at the Magnitogorsk Metallurgical Combine and the "Azovstal' " Plant. In addition to reducing the consumption of coke (to 30%), this made it impossible to improve the quality of the sinter.

The conference noted the intolerable delay in developing and mastering new methods of sintering ores and concentrates (pellets and briquets) and indicated the need in the near future to completely reequip and to master the device for producing sintered pellets at the Yugo Combine.

The increase in the basicity of the sinter up to complete elimination of raw limestone from the charge of all blast furnaces was recognized as an important task ofthe sinter-plant operators.

In order to produce a sinter constant in chemical composition and to provide an even rate of the blast furnaces at a constant heating of the blast, it was deemed necessary to create reserves of ore and flux sufficient for careful blending at the mines, metallurgical plants,and mining-concentration combines. In order to increase the quality of the sinter it is necessary to crush the fuel and flux to 2 mm prior to sintering and to reduce the limit of grain size of the sintered ore to 6-8 mm. An improvement in the quality of the raw material will permit a considerable increase in the output of the blast furnaces.

Reports on the three following directions were discussed at the symposia on blast-furnace production:

1) A theoretical analysis and practical experience of using a combined blast.

2) Experience of operating large-volume blast furnaces and their equipment.

3) Mechanization and automation of the blast-furnace process.

The delegates who reported noted that the introduction of a combined blast (natural gas and oxygen) permits a considerable improvement in the technical and economic indexes of smelting. However, there is still much to be done for the successful introduction of a combined blast at all furnaces. It is necessary to set up lot production of oxygen devices of high capacity, to improve the supply of the RSFSR plants with oil-well gas and natural gas, to reconstruct the blast stoves for the purpose of heating the blast to 1200°. The conference resolved to carry out, in 1961,an industrial check at several plants of the effectiveness of the combined blast (with an oxygen content of 30-35%).

Lively debates developed concerning the question of forcing the smelting process.

Having examined the experience of operating large-volume furnaces, the conference noted that blast furnaces of 1719 m^3 operate economically and with high productivity. The conference recommended that when designing furnaces with a larger volume the transverse dimensions of the profile be increased, the capacity of the hearth be increased by increasing its height, the arrangement be changed of the pigiron and slag tap hole, etc. It is also necessary to increase the capacity of the burners of the blast stoves to 70-80,000 m^3/hr, to develop valves for operating with a blast heated to 1200° under a pressure of 4.2 atm (gage), small-size electric tap-hole guns with a pressure on the piston of 250 t, etc.

The conference noted that in connection with the increase in the productivity and the increase in the volume of the blast furnaces, a severe lag is detected in the region of mechanizing the hearth operations. It is necessary to develop equipment for replacing the tuyeres and slag devices, for repairing and ramming the chutes and casing of the pig iron tap hole; to select the optimum composition of the tap-hole mass; to mechanize its preparation and delivery to the furnaces; etc.

On the question of automating the blast-furnaces process, the conference pointed out the unsatisfactory rate of scientific-research and designing studies on the development of instruments and means of automation. However, the conference noted that prime attention should be devoted to the preparation of raw material and to assure stable conditions of the blast-furnace process. It was acknowledged as expedient to use individual automatic units for controlling the parameters of the furnace regime until completion of the work on large-scale automation.

The conference also noted that direction of the main scientific-research and design studies for future years. The realization of the measures recommended by the conference will help theblast-furnace operators to solve tasks established by the Seven-Year Plan for the development of the national economy.

Development of Blast-Furnace Production at the Kuznetsk Metallurgical Combine

B. N. Zherebin, V. M. Minikin, L. Ya. Matusevich, V. G. Guryanov, Yu. A. Markhasin, D. A. Shtyrev, Moscow, Metallurgizdat, 361 pages, 1960.

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p. 14, February, 1961

The authors of this book report certain information on the raw-material base and chiefly elucidate the achievements of blast-furnace production at the Kuznetsk Metallurgical Combine.

The authors devote great attention to the improvement in the construction of blast furnaces, auxiliary structures and equipment, and also to the problems of automation and mechanization of production, organization, and to the carrying out of normal and capital repairs of blast furnaces.

The aim of the book is to make known the advanced operating experience of the Kuznetsk blast-furnace operators for the purpose of its possible use at other metallurgical enterprises of the country.

The book can be useful to engineers and technicians, highly qualified workers, and also to students of metallurgical institutions of higher learning.

OPERATION OF A FURNACE WITH HEAT INSULATED ROOF

V. P. Borodin, G. F. Marchenkovskii, P. E. Darmanyan,
A. A. Yudson, and B. N. Kurochkin

"Krasnyi Oktyabr' " Plant and VNIIMT
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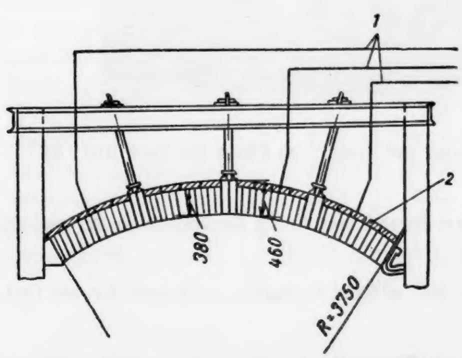
Replacing the Dinas refractories by magnesite-chrome refractories in the roof lining of the top structure of open-hearth furnaces has increased their productivity due to the more intense thermal system and the accompanying increase in the operating temperatures of the furnaces. However, with changeover to a basic roof, due to the high thermal conductivity of the magnesite-chrome components compared with Dinas components, heat losses have occured through the roof lining, which has also increased the fuel consumption.

At the "Krasnyi Oktyabr' " Plant the changeover to basic roofs was also accompanied by an increase in the specific consumptions from about 7 to 12%, depending on the tonnage of the furnace. In connection with this the thermal insulation of the main roofs of basic open-hearth furnaces in recent years is considered as a means not only of reducing the fuel consumption, but also of increasing the furnace productivity.

In 1959 at the suggestion of VNIIMT this system was started at the "Krasnyi Oktyabr' " Plant in the low-tonnage furnaces. The fuel consumption in the small furnaces averaged 346 kg/ton of useful steel during 1958, and in the last campaign before thermal insulation of the roof it was 315 kg/ton.

In June, 1959 at one of the small furnaces of our plant, the main roof of supported-suspended design was insulated, using 380-mm magnesite-chrome brick as a lining. The roof has three rows of suspension along the length with a height of the suspended brick of 460 mm.



The 12 upper rows of the regenerator checkwork were lined with forsterite brick, the bottom row with PM-48 fireclay. The cross section of a cell was 140 × 140 mm. The furnace is fired with a gas and fuel mixture. The atomizer is compressed air at a pressure of 4-4.5 atm, the fuel oil is fed at a pressure of 4.0 atm and heated to 70-80°. The pressure of the natural gas is 2.5-3.0 atm.

In the furnace, mainly low-carbon steels are melted with the scrap process.

At the 9th heat overhaul, when the roof had been thoroughly and uniformly burnt, cracks and slits on the outside surface were filled with magnesite powder with scale (1:1). The whole area of the roof between the longitudinal cross pieces was then insulated with light-weight BL-1 brick laid flat (height of thermal insulation 65 mm). The roof surface under the longitudinal cross pieces was left bare for normal cooling (Fig. 1). To check the change in temperatures under the insulation at three points along the roof arch (opposite the middle charging hole) thermocouples connected with a recording galvanometer were placed under the light-weight fireclay brick.

Markers were used to observe the change in configuration of the roof (Fig. 2). In the first heat the distance was measured from the top end of the tube to the bottom end of the rod. The change in this distance throughout the campaign characterizes the change in configuration of the roof.

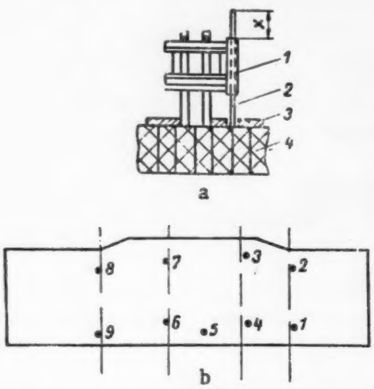


Fig. 2. Fastening of marker a and rational arrangement of markers on the roof: 1) Tube; 2) marker; 3) insulated brick; 4) basic roof; x) distance measured.

The first campaign of the furnace with thermally insulated roof lasted 138.5 days; 433 heats were smelted. The shutdown for overhaul was due to the poor state of the bottom structure. An examination showed the roof condition to be satisfactory: the furnace could give another 50-80 heats. The average residual thickness of the brick along the front line was 180 mm, along the back line 170 mm, and in the center of the roof 130 mm (Fig. 3); the wear of the roof during the heat averaged 0.46, 0.48, and 0.57 mm, respectively. There were no serious traces of strains in the magnesite-chrome brick. The roof brick was efficiently welded in the form of a single structure.

The state and temperature system of the thermally insulated furnace was checked by a stationary and portable control and measuring apparatus, and also visually.

The temperature under the insulation was increased smoothly and continuously; in the last heats it reached 1080-1100°. Consequently, at the part where the roof brick had thermal insulation the temperature did not exceed the permissible limit at which the structural strength of the lining is reduced, and it was below the refractoriness of the insulated brick.

It should be mentioned that the temperature under the insulation was higher along the center of the roof and was lower toward the front and back walls. During the campaign the roof was blown several times. After each 50-100 heats a thermal probe was used to measure the surface temperature of the insulation. Its maximum temperature along the front line was 240°, along the back line it did not exceed 170°, and at the roof of the heads it was 130°.

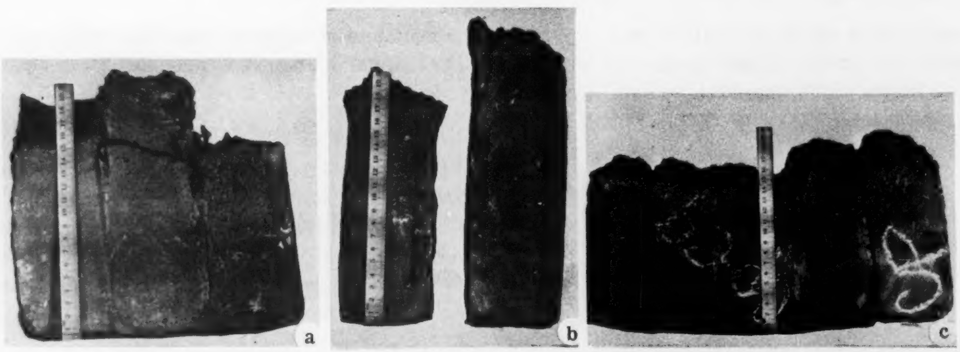


Fig. 3. Average residual thickness of brick along the lines of the roof and center. a) Along the back line; b) along the front line; c) along the center.

Measurements of the marker positions after every 25-30 heats showed that during the campaign the magnesite-chrome brick under the insulation was practically undeformed.

The furnace with a thermally insulated roof operated hotter than without insulation, with considerable fuel economies.

The increased accumulation of heat by the lining of the thermally insulated roof created a more stable temperature system in the furnace and made it possible to reduce the thermal load by 7-12% during the periods of the heat. The thermal loads, in millions of kcal/hr, were:

	Without roof insulation	With roof insulation
During charging	8.15	7.6
During melting	9.25	7.9
During rimming	8.85	7.2

On November 21, 1959 the main roof was again insulated after the furnace had been overhauled. In contrast to the previous campaign, due to the shortage of brick at the plant, the main roof was lined with 300-mm magnesite-chrome brick and the insulating material was light-weight fireclay with specific gravity 0.8, height of insulation 30 mm. This time the campaign of the furnace with thermally insulated roof was 365 heats (113.6 days). The furnace again ran hotter. As in the previous campaign, there was a smooth increase in temperature under the insulation along the back and front lines. The temperature was continuously increased, reaching 800° in the last heats.

After about 45 days operation along the front lines of the furnace there was a sharp increase in temperature, and by 360 heats the temperature along the front line had reached 1100°. The reason for this is presumably the chipping of the brick due to temporary excessive cooling in some heats during the charging period and during hearth repair. During this campaign the thermal loads could be lower than in the previous campaign.

During the campaign the loads in the different smelting periods averaged (in millions of kcal/hr):

during charging	7.1
during melting	7.24
during rimming	6.44

During operation it was found that the thermal insulation of the roof slows up the aging of the furnace.

Indices	Furnace campaign I: without insulation	Furnace campaign II: with thermally insulated roof	Furnace campaign III: with thermally insulated roof
Number of heats with regard to roof and checkwork	433	433	365
Average daily production, tons per day	83.2	88.2	90.2
Hot idle time, %	5.3	2.46	2.1
Productivity, hr-min:			
heats	7.55	7.28	7.20
dressing	0.20	0.20	0.20
charging	2.33	2.34	2.29
melting	3.17	3.02	3.03
rimming	1.45	1.32	1.28
Specific consumption of fuel, kg/ton	315.3	249.2	259.7

The table gives comparative data for the production indices of a furnace with thermally insulated roof and without insulation. As can be seen from the table, from the data of two campaigns with an insulated roof the time of melting and rimming was reduced, as a result of which the furnace productivity increased by about 6.5% during this time. There was a considerable reduction in the fuel consumption: during the two campaigns the savings in fuel was 55-66 kg/ton or 17-21%.

This high economy is probably due to the fact that the experiments were carried out in low capacity furnaces, for which the relative development of the lining surface to their tonnage is very important.

The favorable results for the thermal insulation of main roofs of open-hearth furnaces has led this plant to extend this experience to other furnaces. Three furnaces are now operating successfully with thermal insulation. It is intended to install thermal insulation in other furnaces of the plant.

A NEW DESIGN OF A MOLD TROLLEY

F. V. Palaguta

Izhorsk Plant

Translated from Metallurg, No. 2
pp. 17-20, February, 1961

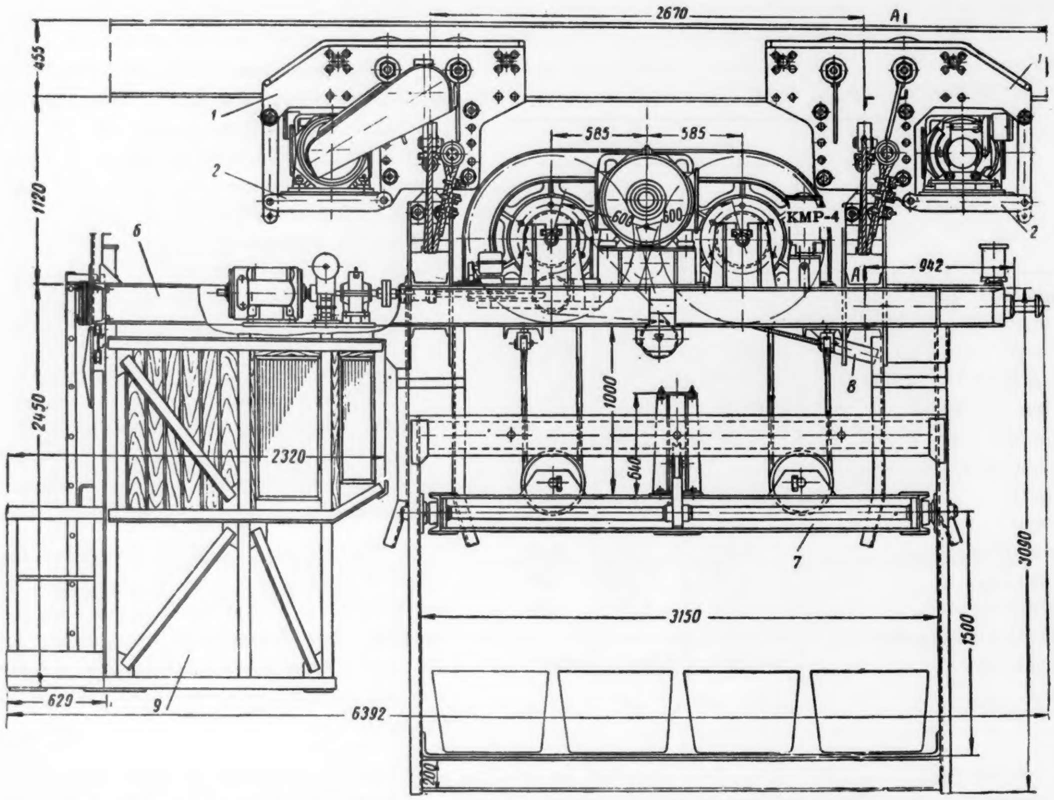
There are a number of design faults in the suspended monorail trolley for transporting molds produced by the "Krasnyi Metallist" Plant and also the firm "Shalton" operating at the Izhorsk Engineering Plant.

The suspension of the frame of the trolley to the moving carriages is rigid through cross pieces without shock absorbers. When moving over irregularities and the joints of the carrying monorail there are sharp blows leading to tearing of the suspension device.

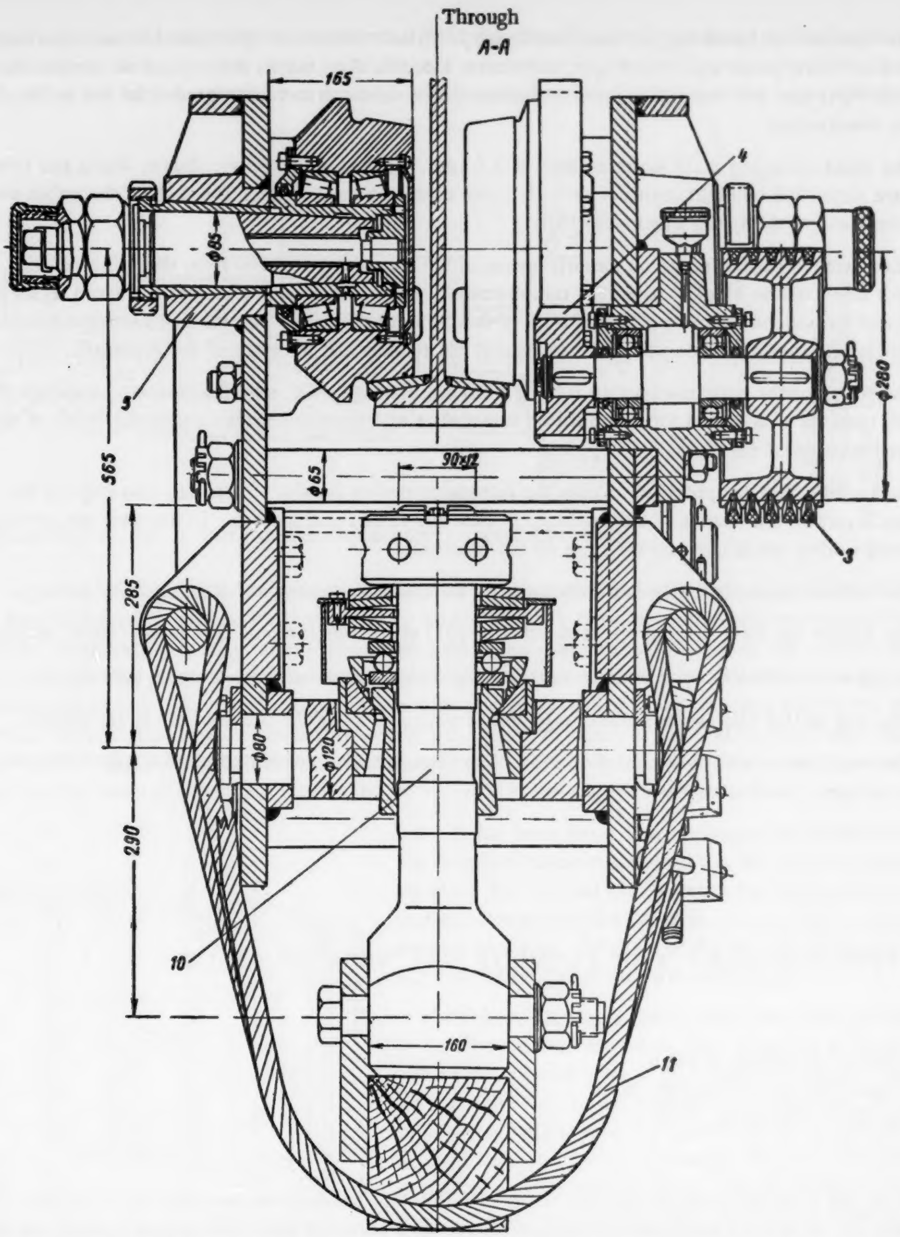
The suspension device itself does not permit deviations of the trolley in a plane perpendicular to the direction of movement. When moving around bends the centrifugal forces cause bending stresses in the suspension, leading to breaks in the components. These forces, acting through the suspension device on the traveling part of the trolley, distort it, due to which skidding takes place and rapid wear of the runners.

The mechanism for opening the clamps on the monorail trolley of the "Shalton" firm has a manual drive. Much physical effort is needed on the part of the operator to open the clamps.

The fastening of the shafts of the runners in the frame of the trolley does not allow for tightening when they become weak. The shafts rapidly wear and fail.



New mold trolley. 1) Moving carriages; 2) area near electric motor; 3) V-belt transmission; 4) pinion; 5) axle boxes; 6) rigid welded frame; 7) frame of mechanism for clamping molds; 8) shock absorbers; 9) operator's cabin; 10) spherical suspension device; 11) stops.



Designers at the Izhorsk Plant, M. N. Pisarev, F. V. Plaguta, T. A. Sveshnikov, Yu. N. Zolin, and Yu. A. Orlov have developed a new 10 ton monorail trolley to transport four molds (see figure p. 72).

The trolley is hung on two moving carriages, each of which has four runners, two of them driving. The drive for the runners is provided by an electric motor suspended on the area, of 7.8 kw power, n = 1130 rpm, through a V-belt transmission and pinion to the gear rim of the driving runner. The speed of the trolley along the monorail is 210 m/min.

The shafts of the runners are fixed in tapered bushes which makes it possible to tighten the shafts both in the runners and in the axle boxes. The runners rotate on pairs of tapered roller bearings. The design of the runners permits rapid replacement without dismantling the carriages.

The mechanism for raising the load (see figure p. 73) is mounted on a rigid welded frame and consists of an electric motor of 33 kw power and n = 830 rpm, a reducer, a double shoe brake, driving and driven pinions, and two drums with right-and left-threaded grooves. In addition, one of the drums has a groove for the cable of the mold clamping mechanism.

The mold clamping mechanism consists of a frame, clamps, guide pillar, sliders, shafts, and levers. The clamps are suspended on eight branches of a 16.5 mm diameter steel cable. The ends of the cable are fastened to the drums and to the spring shock absorbers.

The clamp is controlled by an electric motor of 2.5 kw power, n = 1000 rpm, through a reducer, tightening block with screw, guide blocks, and an 8.8 mm diameter steel cable, one end of which is fixed to the spring shock absorber and the second is fastened to the drum of the hoist mechanism. The moving carriages have horizontal guide rollers eliminating friction between the rim of the runners and the edge of the monorail.

The frame of the hoist mechanism is hung from the carriage by a spherical suspension device, thrust bearing, and shock absorber with dished springs to soften blows sustained when the trolley passes the joints of the monorail and curved sections of the track.

Steel cable stops are provided in case the suspension device breaks. There are also stops in the form of transverse cantilevers on the frames of the carriages in case the runner shafts break. In this case the carriages and the whole mold trolley would hang by the stops on the monorail.

The welded operator's cabin is rigidly hung on the frame, is heated and lined on both sides.

The trolley has hoist limiters (final switch KU-131) and an unclamping mechanism (final switch VK-211).

To prevent collisions between neighboring monorail trolleys there is a system of light signals.

This new trolley eliminates design faults which were present in the previous monorail trolleys.

The use of new mold trolleys at the Izhorsk Plant has provided an uninterrupted supply of charge and other material to the open-hearth furnaces.

IMPROVING THE TONGUE OF FLAME IN THE WORKING SPACE

G. I. Moiseevich and E. M. Kondrat'ev

Stalino Metallurgical Plant
Translated from Metallurg, No. 2
pp. 20-22, February, 1961

There are some generally recognized faults in the Venturi heads connected with unsatisfactory mixing of the gas and air, especially when their consumption exceeds a certain limit. Due to poor mixing, the tongue of the flame is often displaced toward the front or back walls. This phenomenon can be observed through windows made in the ends of the heads. The part of the bath adjoining the wall from which the tongue is displaced is not covered by the flame; at the opposite wall the bath is covered with the tongue and the flame runs up this wall. When the tongue is displaced toward the front wall the flame breaks out from under the covers of the charging doors – the furnace "blows".

Displacement of the tongue of flame also shows up during analysis of samples of combustion products, taken from three vertical channels in the exhaust head. For example, when the tongue is displaced toward the front wall the samples of combustion from the front channel contain a large proportion of unburnt fuel components; in the samples taken from the back channel there is a large amount of free oxygen, and there are no fuel components (Fig. 1). The reverse is the case when the tongue is displaced toward the back wall.

The displacement of the tongue of flame from the axial direction limits the thermal operation of the furnace; since there is then increased wear in the walls, there is a reduction in the heating capacity of the flame, because over one part of the bath the combustion proceeds with incomplete burning and over the other with a large excess of air.

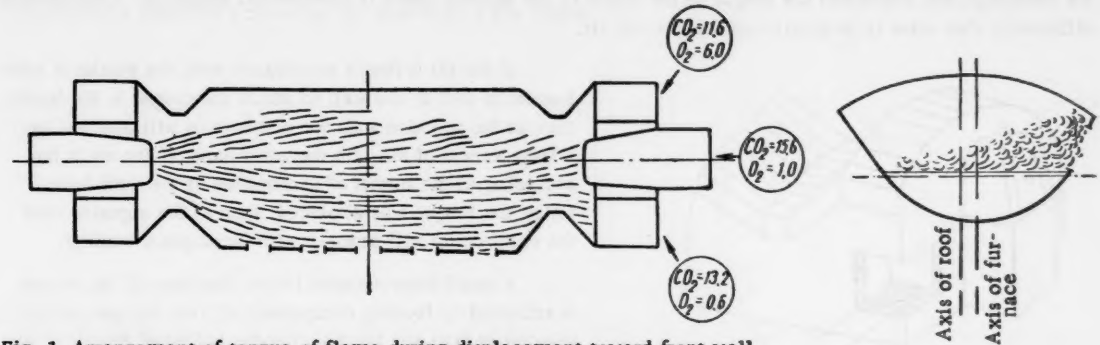


Fig. 1. Arrangement of tongue of flame during displacement toward front wall.

With a large displacement of the tongue the coefficient of utilization of fuel is reduced to 0.1-0.15. When the tongue is displaced there is also poor rimming of the bath during the finishing period and uneven heating of the air checkworkers. Overheating usually takes place in the part of the checkworkers adjoining the vertical channel along which the combustion products with incomplete burning are removed; there is insufficient heating in the part of the checkworkers where the combustion products with a large excess of air are delivered from the other vertical channel. This is helped by the unusual design of the bottom structure of the Stalino Plant open-hearth furnaces, where all the slag pockets and regeneration chambers are placed in one row and each slag pocket is connected with its regeneration chamber by two doors in the wall separating them (Fig. 2).

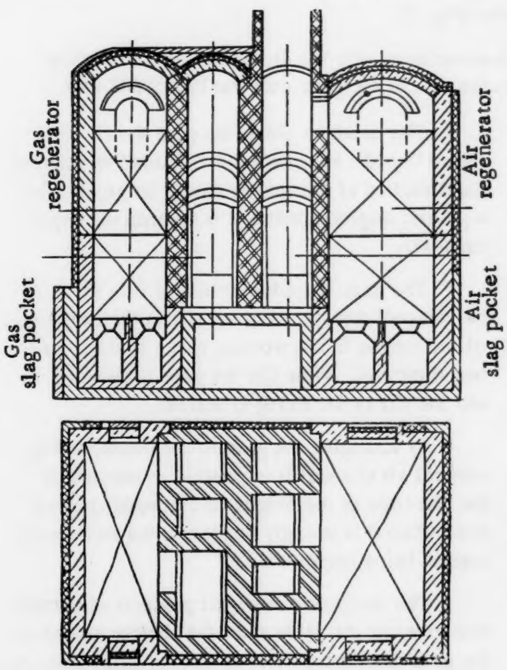


Fig. 2. Arrangement of slag pockets and regenerators of the Stalino Plant open-hearth furnaces.

It has been found that the degree of displacement of the tongue of flame is affected by: the uneven delivery of air along the vertical air channels, the thermal load, incorrect arrangement of the caissons, uneven filling of the slag pockets with slag, the slope of the bottom of the gas passage and the height of the bath surface, etc.

If more air passes along one of the vertical channels to the furnace than the other, then it arrives in large quantities at the opposite wall to this vertical channel. This redistribution of air in the working space is helped by the presence of high (above the upper edge of the gas passage) air skimmers and the corresponding shape of walls from the skimmers to the narrow section. The air streams leaving the front and back passages pass over the gas streams toward the opposite walls in the working space.

The arrival of more air at one of the working spaces leads to combustion of the fuel along this wall with an increased excess of air and to the "forcing" of the tongue to the opposite wall. Due to the insufficient supply of air the fuel here does not burn completely and the tongue is drawn out and runs up the wall.

The redistribution of air feed passing along both vertical channels can occur during the campaign due to uneven filling of the air slag pockets with slag. Then the slag deposits are arranged so that entry of air into one of the vertical channels is hindered to a greater extent than into the other.

The direction of the tongue also depends on the correctness of arrangement of the caissons. To avoid displacing the caissons relative to the position providing good direction of the tongue, at the plant various arrangements were tested during the cold repairs. The best method was to arrange the caissons along the middles of the slabs of the narrow section.

In many cases with correct arrangement of the caissons and a good direction of the tongue at the start of the campaign and afterwards the tongue of the flame in the working space is nevertheless displaced. Considerable difficulties then arise in proportioning the gas and air.

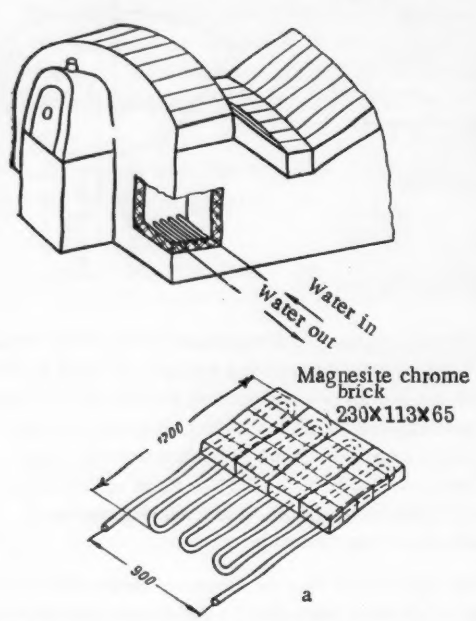


Fig. 3. Arrangement of gate in the front air vertical channel of the left head of the furnace: a) water cooled gate-coil, lined with brick.

If the air is fed in accordance with the results of combustion of fuel at the wall to which the tongue is displaced, then at the opposite wall the combustion will proceed with a large excess of air. On the other hand, if the air is fed according to the results of combustion at the wall from which the tongue was displaced, then at the opposite wall the combustion will proceed with incomplete burning.

A small improvement in the direction of the tongue is achieved by feeding compressed air into the gas passage (ejector or fan) and by changing the height of the air skimmers of the heads. However, a radical and rapid improvement in the direction of the tongue can only be obtained by reducing the cross section of that vertical air channel of the feeding head toward which the tongue is displaced. For example, when the tongue is displaced toward the front wall the cross section of the front vertical air channel at the feeding head should be reduced.

The cross section of the vertical channel is reduced by a special water-cooled gate made up of a coil of 1 in. iron piping lined on the top with refractory brick laid flat in one row (Fig. 3).

In accordance with the dimensions of the vertical channels the size of the gate-coil was 1200 x 900 mm.

Analysis of Combustion Products from Vertical Channels,% *

Period of operation of furnace	Front air channel		Gas channel		Back air channel	
	CO_2	O_2	CO_2	O_2	CO_2	O_2
Before arranging gate	14.2	0.4	15.8	1.5	13.2	5.0
	14.0	0.2	16.0	1.2	13.6	4.0
	13.8	0.2	16.2	1.0	13.4	4.8
After arranging gate	15.4	1.6	16.2	1.2	15.8	0.8
	15.2	1.4	16.0	1.4	15.6	1.0
	15.2	2.0	16.4	1.4	15.4	0.8

* The analyses refer to the combustion of fuel under approximately the same thermal loads and during the same period of smelting before and after arranging gate.

The depth to which the gate should be inserted into the appropriate air channel to improve the direction of the tongue should be greater for a greater displacement and is determined experimentally.

The gate is gradually moved into the vertical channel through a narrow slit in the lining until the tongue in the working space assumes its best direction. After this the gate is fastened and the slit in the lining is sealed.

By arranging the gate in the corresponding vertical air channel it is possible to regularize the direction of the tongue in the working space even when it is strongly displaces, the furnace operation being improved.

The analyses of the exit products of combustion given in the table show that before arranging the gate there were cases of uneven combustion of fuel along the width of the furnace: at the front wall the combustion was incomplete, and at the back wall there was an excess of air. The tongue was visibly displaced toward the front wall.

After arranging the gate the composition of the combustion products across the width of the furnace became more uniform and the direction of the tongue was symmetrical.

We started using gates to control the direction of the tongue in 1957. Since this time the gates have shown good durability: one gate has been working several years without burning.

Reducing the cross section of the vertical air channel by means of a special water-cooled gate is therefore an effective means of improving the direction of the tongue.

MILL FOR ROLLING PERIODIC SHAPES

N. P. Borodii

Senior Foreman of the Dzerzhinskii Metallurgical Plant
Translated from Metallurg, No. 2
pp. 23-24, February, 1961

A 120 three-high mill for transverse screw rolling of periodic shapes was put into operation at our plant in 1959.

The new process-transverse screw rolling on a three-high-mill was developed by Soviet scientists under the supervision of A. I. Tselikov, Corresponding Member of the USSR Academy of Sciences.

The new process of rolling periodic shapes makes it possible to save an appreciable amount of metal at machinery-building plants.

A billet with a diameter up to 120 mm prior to rolling is heated in electric induction furnaces having a power of 500 kw operating on a two-frequency regime: on the industrial frequency of 50 cps at a voltage of 525v to 723°, and on a frequency of 1000 cps at a voltage of 1500 v from 723 to 1250°. The entire heating process and

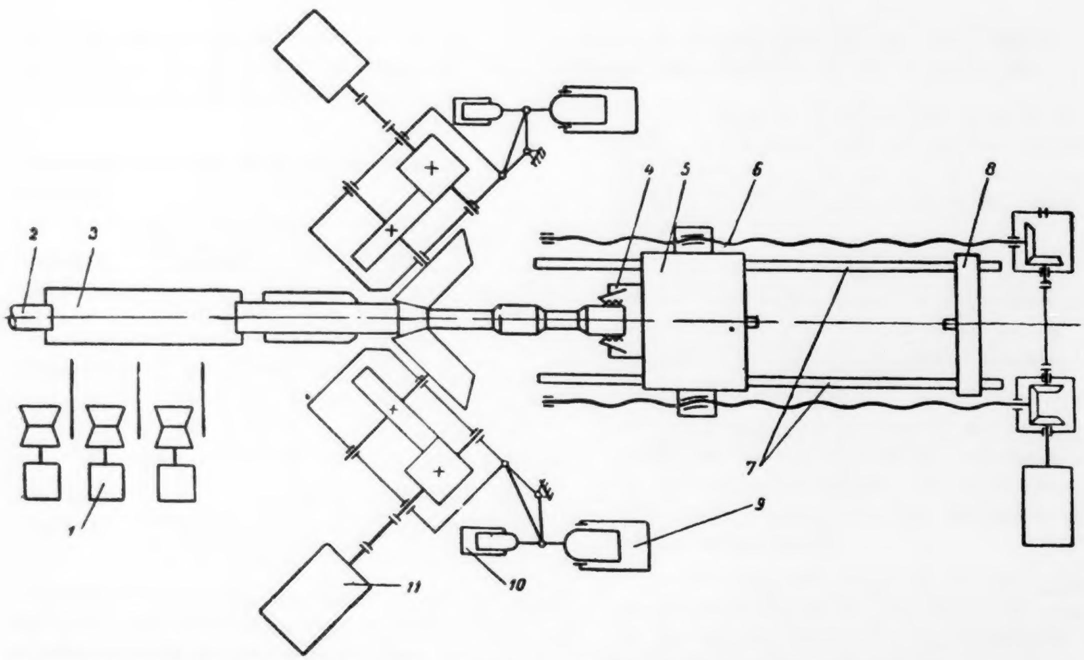


Fig. 1. Functional diagram of the 120-mill. 1) Delivery roll table; 2) pneumatic push rod; 3) receiving trough; 4) automatic clamp; 5) carriage; 6) feed screw. 7) guides; 8) movable stop; 9) working cylinder; 10) return cylinder; 11) electric motor (N = 180 kw, n = 800-1100 rpm).

its control is accomplished automatically by means of a contactor-type relay apparatus. The consumption of electrical power per ton of metal heated is 400 kw-hr.

The functional diagram of the mill for rolling periodic shapes is given in Figure 1.

The heated billet is transported from the induction furnace by the delivery roll table to the mill, where it is directed by a dumper into the receiving trough. Then the billet is delivered by the pneumatic rod pusher through a guide and opened rolls to the automatic clamps of the carriage during the movement of which, the rotating rolls either draw together or separate, thus reducing the billet and imparting the given shape. The rolls are arranged at an angle of 120° relative to each other and at an angle of 45° to the axis of rolling.

The mill is controlled by a special hydraulic duplicating system (Fig. 2).

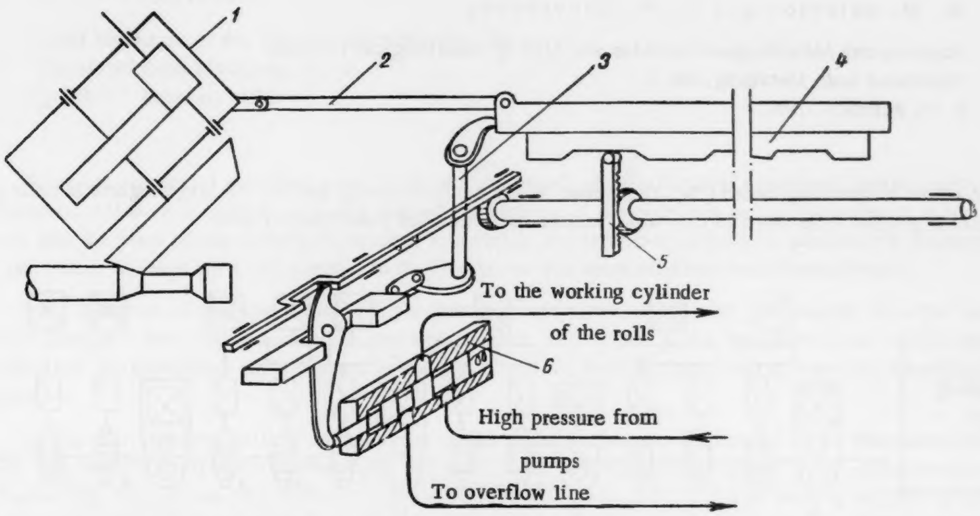


Fig. 2. Functional diagram of the duplicating system. 1) Working stand ; 2) rod for reverse action ; 3) reversing coupling ; 4) duplicating guide ; 5) sliding rack and pinion gear ; 6) follow-up valve.

As the carriage moves, the sliding rack and pinion gear move with it. The roller as it rolls along the duplicating guide transmits certain pulses through the kinematic chain to the follow-up valve which, when the rolls touch the metal, connects the working cylinder of the rolls with the high-pressure channel (80-100 atm), when the rolls separate, closes it and connects the working cylinders of the rolls with the overflow line.

The rolls were separated by return cylinders (Fig. 1) to which oil under high pressure was constantly supplied and the area of which was smaller than the area of the working cylinders. The rolls are stopped in a given position by the action of the reversing coupling on the follow-up valve. In this position the oil in the working cylinder is closed off.

The basic data of the 120-mill are given below.

Largest diameter of the starting billet, mm		120
Largest diameter of the rolled shape, mm		120
Smallest diameter of the rolled shape, mm		40
Greatest length of the shape after rolling, mm		4000
Shortest length of the intermediate part between two large diameters, mm		30
Length of unrolled front end of rod, mm	not less than	120
Length of unrolled rear end of rod, mm	not less than	50
Largest angle of introducing the rolls to the metal, deg.		45
Largest exit angle of rolls from metal, deg.		20
Maximum permissible reduction, mm		2

More than 15 periodic shapes of different configurations have been mastered on the mill for the needs of machinery-construction plants. The introduction of the new process of transverse screw rolling on the three-high mills will make it possible for us to save thousands of tons of metal and will release mills and press machinery-construction forging equipment.

SPREADING PASSES ON A STRIP MILL

M. M. Shternov and N. V. Litovchenko

Magnitogorsk Metallurgical Combine and Mining-Metallurgical Institute
Translated from Metallurg, No. 2
p. 25, February, 1961

A series of spreading passes (Fig. 1) are used on the continuous strip mill at the Magnitogorsk Metallurgical Combine to produce strip 260-270 mm wide because the billets are insufficiently wide.

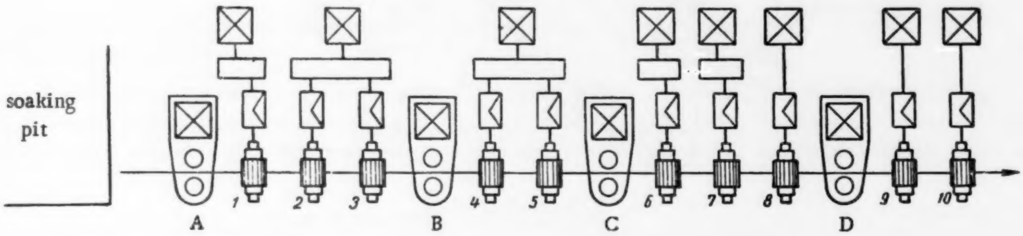


Fig. 1. Diagram of the layout of the continuous strip mill. 1-10) Stands; A-B) edgers.

A strip with a central line of sufficient length is formed in the first two passes (Fig. 2) due to the wedges cutting in. The task of the next passes (3, 4, 5 stands) is to spread out the shape smoothly. Edger B (a stand with vertical rolls) is not used while rolling with the spreading passes.

The forced delivery to the first stand by means of edger A permitted the use of a bite angle up to 32-35° with respect to the crests of the wedges. The correct mutual axial position of the rolls in this stand is assured by using special catches on the shoulders. The rolls in the other stands occupy the correct position due to the balance of the axial forces acting on them. Widening in the passes is not limited since the strip width is regulated in the edgers located beyond the spreading passes.

The first batch of wide strip was rolled satisfactorily. Strip with a width of 260 mm is produced from a billet whose dimensions after edger A are 200 x 85 mm. No defects were detected on the finished shape as a result of using the spreading passes.

All motors of the mill operate at a certain overload since they were not calculated to roll such wide strip.

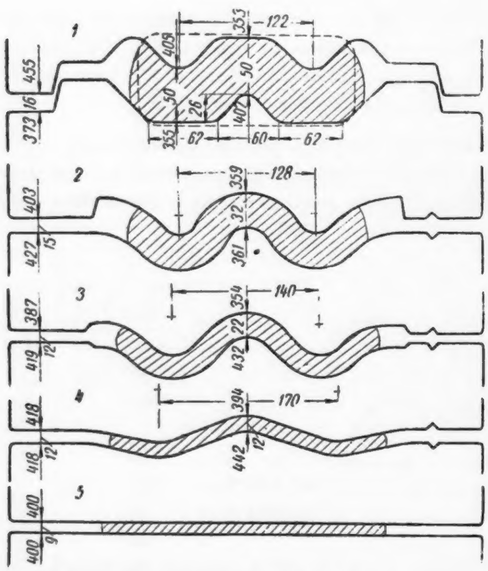


Fig. 2. Spreading passes. 1-5) Stands.

Careful observation of the behavior of the metal in the spreading passes should be the subject of a special study. Of especially great interest here is the establishment of the optimum changes in the angles of slope of the crests from pass to pass and the regularities in the movement of metal laterally. A method for calculating the width of finished strip produced by using the spreading passes should result from such an investigation.

REPAIRING UNITS OF ROLLING EQUIPMENT

G. V. Antsyshkin

Chief Mechanic of the Zlatoust Metallurgical Plant
Translated from Metallurg, No. 2
pp. 26-27, February, 1961

There are no special assembly areas for on-the-job repair of metallurgical equipment (particularly rolling equipment). All work is carried out in the immediate vicinity of the operating units. Therefore,it is completely natural that the plant repair collectives attempt to simplify and facilitate as much as possible the dismantling and assembling of large units and attempt to develop better and more efficient conditions of repair.

Long operation of equipment makes it possible to detect errors, which were permissible when the equipment was first designed, that can be avoided in new designs. But, unfortunately, the designers do not always take into consideration the experience accumulated by the plants and the specific conditions of repairing metallurgical equipment.

On the 950-blooming mill of our plant the design called for an interference fit on all three steps (diameter of 470, 420, and 370 mm) in the bronze three-step nuts of the forcing screws installed in the upper crosspieces of the frame (Fig. 1a). It was very difficult to replace these nuts (their pressing out or pressing on) due to the exceptional inconvenience and complete lack of a repair area. In order to press the nuts onto the frame special devices were made and 20-ton hydraulic lift jackets installed. Two to two and a half days were needed to repair the screwdown gear together with pressing the nut out and pressing it on.

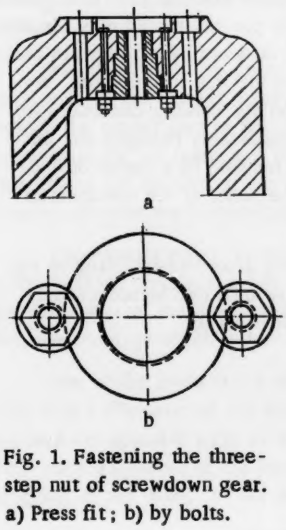


Fig. 1. Fastening the three-step nut of screwdown gear. a) Press fit; b) by bolts.

Operational experience has shown that an interference fit of the nut is definitely not required. The additional fastening by bolts provided for in the design (Fig. 1b) is sufficiently reliable and assures immovability of the nut during operation of the mill. As an experiment we installed bronze nuts not with an interference fit,but with a loose fit having a positive clearance between the fitting steps and the corresponding openings of the frame. The nuts were installed by an electric bridge crane,with a lift capacity of 10 tons,in 2 hours. Removal of the nuts from the frame was also simplified. On the whole the consumption of time and technical means was reduced by a factor of 8-9, and the two nuts themselves were replaced in 3 hr.

The experience of working with nuts having a loose fit confirmed the validity of such an idea for greater efficiency.

The replacement of the bronze bushing of the universal spindle of the 950-blooming mill required dismantling the beams of the beam balance of the upper spindle (Fig. 2a). Dismantling of the units of the balancing device took 6-8 hr, since the pins (axles) of the hinge joints were expanded during operation and the beams could be separated only by cutting these axles with a benzene-oxygen cutter. In addition, the repairmen in this case worked on disassembled lubricated equipment which created not only great inconveniences in working but also increased the possibility of injuring the people.

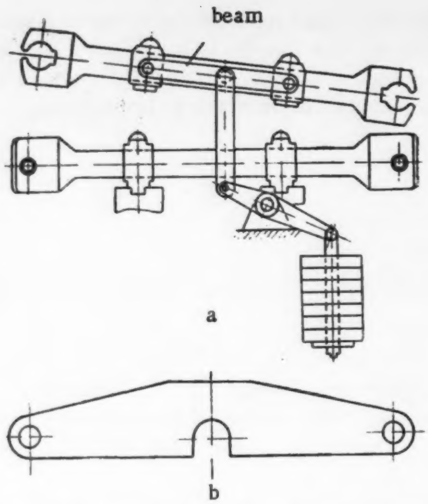


Fig. 2. Beam balancing device of the upper spindle. a) Before converting the beam ; b) after conversion.

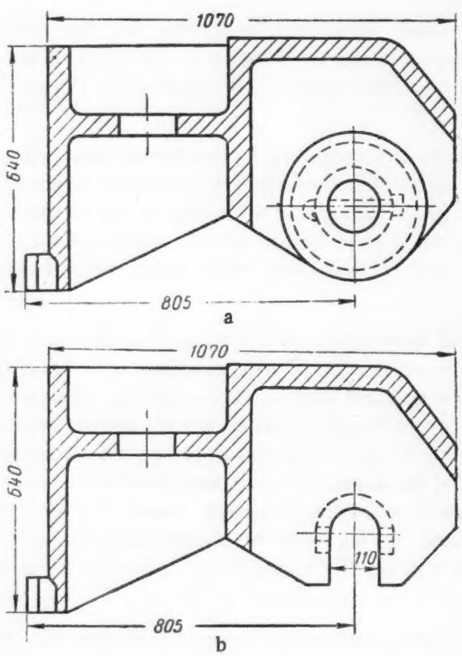


Fig. 3. Guides of the manipulator. a) Before reconstruction ; b) after reconstruction.

The workers of the plant suggested a better design for the beams. Instead of the present openings in the crosspiece for the pins, slots were made and the remaining section of the beam strengthened (Fig. 2b).

Thanks to this change the upper universal spindle can now be removed with complete freedom,together with the beams of the balancing device,and transferred to a free area of the bay for repair and installation of bronze bushings. Now all repair operations are carried out on a free area and there is no need to dismantle the beams of the balancing device. This enabled reducing the time for replacing bronze bushings by a factor of 6.

The guides of the blooming mill manipulator traveling on rails along the rollers of the working roll table have rollers mounted between the sides of the guides, in which holes for the pins of the rollers are provided for in the plan.

As a result of the heavy loads during turning of the ingots and straightening the bloom or slab,and also as a result of the high temperatures (150-200°), the bushings or special rolling-contact bearings of the rollers in the most loaded tilting guide of the manipulator are frequently put out of operation and they are replaced with new ones while the mill operates. The greatest difficulty in replacing the old roller with a new one is to take out its axle which is always expanded and can be removed only by pressing it out after preliminary treatment with a benzene-oxygen cutter. The repair personnel must work in the high-temperature zone (hot guides) for 1.5 hr.

The workers of the plant slightly changed the unit for fastening the axles of the rollers on the tilting guides of the manipulator. Instead of holes for the axles in the sides of the guide (Fig. 3a), grooves were made (Fig. 3b) into which were installed the rollers with pre-assembled pins. In this case the axle of the roller is fastened by a cotter pin passing through a half-ring welded to the side of the guide. As a result of such a reconstruction the working conditions for the repair personnel were considerably changed and the idle times of the equipment reduced by a factor of 5-6. The entire replacement of the roller of the manipulator guide now takes 15 min.

The experience we have described fir changing certain units of the 950-blooming mill can be successfully used also at other metallurgical plants.

ROLLER WITH A HAIR BRUSH FOR CLEANING SHEETS

V. P. Emel'yanov

Magnitogorsk Metallurgical Combine
Translated from Metallurg, No. 2
p. 27, February, 1961

Before sheets of transformer steel are annealed they are covered with talc in order to prevent their welding. After annealing, the talc is removed from the sheets on cleaning machines which did not properly clean the metal and therefore the sheets frequently had to be cleaned by hand.

F. N. Khisamov and N. V. Peksimov, efficiency experts of the combine, suggested replacing the nondriving felt roller of the cleaning machine with a roller having a hair brush, which receives a forced rotation from the upper driving roller. This made it possible to eliminate tears in the sheets after cleaning them in the machine and to release four cleaners for the use at other jobs. The savings from the introduction of this suggestion was about 100,000 rubles per year.

RECUPERATIVE SOAKING PITS WITH TOP TWO-WAY HEATING

V. I. Kurpe, Foreman of the Soaking Pits, and G. N. Khristoforov, Senior Welder

"Avovstal' " Plant
Translated from Metallurg, No. 2
pp. 28-29, February, 1961

The automated recuperative soaking pits built during the post-war period that are heated from the center of the hearth were improved during the course of operation. In October, 1954 the ninth group of modernized soaking pits was built, and many shortcomings which appeared in the operation on the first eight groups were eliminated.

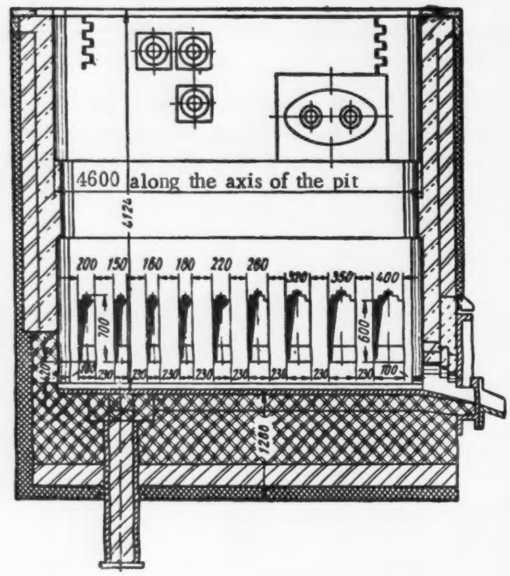
However, even this group has substantial shortcomings affecting the productivity of the pits. Thus, the small path of the central burner to an extremely low position does not permit changing the nozzle of the burner through the burner port as the plan calls for. The replacement of the nozzle by a crane through the working chamber of the pit leads to a decrease in the temperature of the pit. Another shortcoming is the inconvenient cleaning of the regulating gas valve. A brigade of four men spend 4 hr on this operation. At present the valve is being reconstructed according to the type used in the first eight group.

The experimental (ninth) group of soaking pits having horizontally arranged burners and with dimensions of the working chamber of 500 x 4600 x 4724 mm was constructed in August, 1956. The burners were arranged in the upper part of the channeled walls of the working chamber diagonally to the pit. This group had many essential shortcomings which reduced its productivity by 15% as compared with that of the others.

One of the main faults of the pits is the design of the burners. Their outlet side was made as a tapering tube with a diameter of 150 mm in conformity with the plan. With such a design the visible part of the flame reached the opposite walls of the working chamber and the top part of the ingots located opposite the flame. This caused a fusion of the ingots and rapid slag formation on the pit bottom, thus causing slag build-up and clogging of the flues. At the same time the other ingots that wer: insufficiently heated.

After replacing the single-outlet burner nozzle with tips having six nozzles with a diameter of 54 mm arranged at an angle of 12° relative to the axis of the tube, the length of the flame was reduced, which permitted a noticeable reduction in fusion and, consequently, the formation of slag accumulations.

The investigations carried out, however, showed that in spite of the decrease in flame length, utilization of the heat of the gases in the heating chamber and utilization of the heat of the outgoing gases in the recuperators of these pits are worse than in the pits of the ninth group. This is explained 1) by the increase by a factor of 1.5 of the heat losses through the considerably enlarged surface of the working space due to the great height (4724 mm) and 2) by cutting down the number of air recirculations to 4 (instead of 7) in the ceramic recuperators because of reducing their height by two rows and also by the uniflow passage of air, which led to a sharp decrease in the heating temperature of the air (to 600-650°).



Arrangement of the flue ports for the outgoing combustion products in the pits of the ninth group after reconstruction.

It is necessary to note that the liquid slag removal provided for in the plan has not yet been realized due to the insufficient temperature on the pit bottoms as a consequence of their great depth.

Efficiency experts of the shop somewhat reconstructed these pits during regular repairs. Thanks to the installation of ceramic tubes 300 mm high (instead of 390 mm in the lower two rows) the ceramic recuperator was increased from 6 rows to 7. In order to eliminate the uniflow passage of air in the recuperators, the arrangement of the vertical passages were changed, as a result of which the air recuperator became 6-passage and the temperature of air heating increased to 800-850°.

The planned arrangement of the ports for the outgoing combustion products in the pits of the experimental group led to one-way operation of the recuperators and to a good heating only of the corner ingots standing opposite the burners. The position of the flue ports after reconstruction (figure) assured obtaining a fan-like flame evenly distributed throughout the entire pit chamber thus permitting uniform heating of the ingots around the perimeter of the pit chamber.

The great depth of the pit (4724 mm) created difficulties in servicing during heating, charging, and discharging of the ingots and, therefore, the bottom was raised 400 mm.

Reconstruction of the pits of the ninth group increased its productivity by 17.2%, which made it possible to follow a single program of heating ingots for all three types of pits.

Up until 1958, two rows of checkers of the recuperators were made of M-709 carbon chamotte tube ; however, in spite of their good durability the life of the checkers did not exceed 22 months because of the low resistance of types M-706 and M-707 class B chamotte refractory material of the upper cover. Coke dust entrained by the outgoing gases entered into reaction with these refractories, which fused and gradually clogged the tubes of the checkers. As a consequence of this the pit noticeably lost its heating capacity.

The efficiency experts of the "Azovstal' " Plant and the Chasov-Yar Refractory Plant proposed to manufacture types M-706 and M-707 refractories from kaolinized material, the life of which is considerably greater.

In addition, due to the high cost of carbon chamotte tubes and because of their frequent unavailability, it was proposed to use kaolinized tube M-709 whose life is not less than carbon chamotte, and which does not cost more than chamotte.

This proposal made it possible to make the entire checkwork out of only kaolinized tubes, which increased the life of the recuperators to 30 months.

RESISTANCE OF THE MUFFLES OF BELL-TYPE FURNACES

F. S. Astaf'ev

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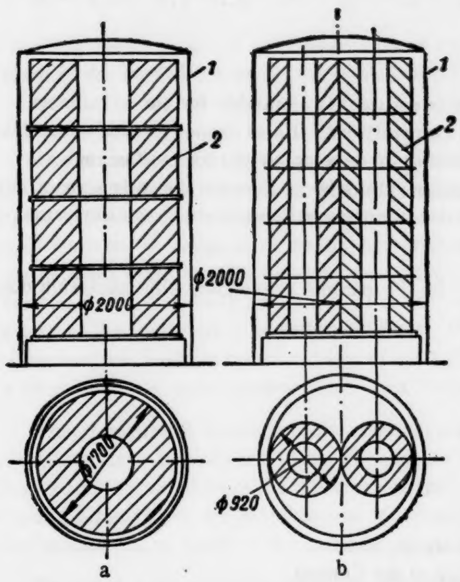
Bell-type furnaces in which metal is heated to 710° (the temperature of the furnace atmosphere is 850°) are used for bright annealing cold-rolled carbon metal (tin-plate, body sheet metal, pickled sheet) in the steel shop. Coils of this assortment weighing 10.6 t each are charged in a pile on four levels (four coils in a pile, figure a).

Cylindrical muffles (3810 mm high, 2000 mm in diameter, 6 mm wall thickness) made of 1Kh18N9T steel serve as the inner covers for protecting the metal from the furnace atmosphere.

Experience in operating the furnaces has shown that the muffles lose their original form comparatively rapidly (about a year) as a result of buckling. This occurs in the following manner. When annealing steel sheet or another carbon metal, the muffle, after removing the outer cover, is cooled uniformly along the perimeter and the geometry of the muffle (cylinder) is retained for a long time. However, due to the acute need for electrical engineering steels, the shop, without changing the structure of the material of the furnaces, began to fill orders for dynamo sheet steel soon after the furnaces were put into operation. In order to avoid welding and buckling of the metal and also to increase the output of the furnaces and to produce the magnetic properties required by the All-Union State Standard, the shop was forced to reel coils each weighing 2.7 t instead of 10.6 t on the five-stand mill. Such coils were set in a pile in two rows each of 4-5 levels (figure b). The metal was heated to 930° (the temperature of the furnace atmosphere was about 1100°). In this case the muffles cooled unevenly after annealing: the section of the wall farthest from the heated metal cooled more rapidly. As a consequence of the high temperature and the asymmetrical arrangement of the coils under the muffle, the muffle after numerous annealings lost its original shape within a year after it was put into operation and it could not be reused without straightening.



a b

Arrangement of coils under muffle. a) Body sheet metal; pickles sheet, steelsheet; b) body steel sheet; 1) muffle; 2) coil.

A simple design of a special cone for straightening the bottom of the muffles was developed at the shop, as a result of which their life was considerably increased.

Another and more substantial cause for the sharp reduction in the life of the muffles is the brittleness of the metal, which occurs under the conditions of the steel sheet shop at the Magnitogorsk Metallurgical Combine after 2-2.5 years of muffle operation. As is known, austenitic steel 1Kh18N9T is subject to intercrystalline corrosion at elevated temperatures which disrupts the continuity of the metal. This occurs as the result of carbon precipitation from solid solution and the formation of chromium carbides which, by being arranged along the grain boundaries of the austenite, disrupts the bonds between them. The chromium carbides impoverish the solid solution and reduce the anticorrosion properties of the steel, after which the steel becomes unsuitable for use.

Under our shop conditions the muffles after 100-130 annealings become unsuitable due to increased brittleness. The operational expenditures per charge is on the average, five rubles.

The main cause of brittleness in 1Kh18N9T steel is carburizing, as confirmed by the following data, %:

Muffle	C	Si	Mn	Cr	Ni	Ti
New	0.09	0.57	1.12	17.59	9.70	0.49
After two years operation	1.15	0,36	1.13	17.27	9.55	0.50
According to All-Union State Standard	≤0.12	≤0.8	≤2.0	17-20	8.0-11.0	to 0.8

The data above shows that the carbon content in the steel increased from 0.09% to 1.15%, i. e., a sharp carburizing occured.

A metallorgraphic analysis established that the new muffle consists of pure austenite, and many carbides are detected in the microstructure of the worn out muffle.

In addition to diffusion of carbon into the metal, which evidently occurs as a result of the effect of the control atmosphere used for bright annealing, the metal of the muffle is also subjected to oxidation during the various periods of heating and cooling. The walls of the muffle are covered by a thin layer of scale which comprises up to 50% of the wall thickness. The loose dark-brown scale forms on the outer wall that comes into contact with the combustion products of the furnace fuel-a mixture of coke and blast-furnace gas consisting of 8% CO_2, 17% CO, 0.3% O_2, 29% H_2, 9% CH_4, 34% N_2.

A dense dark-brown scale forms on the inner muffle wall which is bathed during the entire process of annealing and cooling by a protective gas of the following composition, %: 3-4 CO, 1-1.5 CO_2, 2-4 H_2, 0.5 CH_4, rest N_2. The chemical composition of the scale is given below, %:

Surface of muffle	Fe_{metal}	FeO	Fe_2O_3	Fe_{metal}	SiO_2	Al_2O_3	CaO	Cr_2O_3	TiO_2	C	Ni	Cr	Ti
Outer	none	none	66,5	—	1,80	3,78	none	20.44	0,62	0,01	7,84	—	—
Inner	47,2	16,4	0,70	60,4	2,4	—	—	—	—	0,10	7,9	15,0	0,35

The experiment shows that 1Kh18N9T steel as a scale-resistant steel is unsuitable for use on furnaces using a shielding atmosphere and fuel of the above-mentioned compositions. It also cannot be used economically under conditions of elevated temperatures (to 1100°). It is necessary to develop a steel for muffles such that during long operation it would not change its chemical composition. In order to increase the resistance of the muffles it is necessary to develop a technology for their protective coating and to work out special industrial-type devices.

Annealing of dynamo sheet steel in furnaces not adapted for this purpose is economically unsuitable due to the increased consumption of muffles made of expensive steel.

INCREASING THE QUALITY OF THIN-WALLED TUBES

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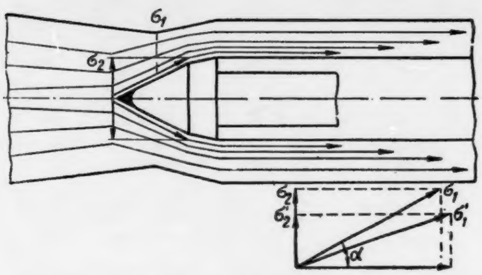
pp. 31-32, February, 1961

In connection with solving the problems of producing large-diameter thin-walled tubes, it is presently very important to reduce to a minimum the number of inside flaws which lessen the quality of tubes. Repair of the inside surface is difficult.

The inside surface of tubes is not repaired at our plant due to the lack of equipment. Practice has shown that when rolling a large-diameter tube (325-273 mm) the output of second class and second quality tubes increases due to the inside flaws. Investigations carried out at the plant established that the cause for the development of inside flaws on the shell and then on the tubes is the formation of a cavity in advance of the nose of the mandrel: when piercing the billet into a shell. The finish on the inside surface of the tube depends first of all on the quality of the starting billet, its heating before piercing, adjustment of the first piercing mill, and then increase of the outside diameter on the first piercing mill.

Monitoring of the piercing temperature of each shell on the first piercing mill of the installation showed that in each heat during a normal rolling rate there are shells with a lowered piercing temperature within the limits of 1150-1180°. An examination of the tube rolled from such billets showed that 32.3% of them have inside flaws. This attests to the fact that, with all other conditions being equal, a drop in piercing temperature by 70-100° (and consequently the ductility of the metal) severely affects the quality of the inside surface of the tube. Therefore, now when rolling tubes with diameters of 325 and 273 mm, the billets are heated in two furnaces for the best transverse and longitudinal heating. Cases of overheating were not detected.



Longitudinal cross section of the deformation zone.

On the basis of studying the macrostructure of delayed billets, we established that the formation of a cavity ahead of the mandrel nose is the result of nonuniform deformation and the phenomenon of an axial bending force associated with it. Twisting of the billet also favors opening of a cavity. In our opinion radial tensile stresses, which arise from the effect of the tangential forces displacing the metal around the circumference of the billet, when they are large can lead to ruptures of the center. The scheme of radial tensile stresses during piercing is shown for a longitudinal cross section of the deformation zone (see figure).

When piercing, it is necessary to attempt to reduce the bending forces σ_2 which are components of the directional forces σ_1. This can be attained by reducing the increase in the outside diameter (the relationship $\frac{D_{shell} - D_{billet}}{D_{billet}}$).

The presence of two piercing mills on the 400-unit makes it possible to freely vary the outside diameter, i. e., to decrease it on one of them and increase it on the second. As the investigations showed, for low-carbon steel an increase in the outside diameter on the second piercing mill does not affect the quality of the inside surface of the tube. A decrease in the outside diameter on the first piercing is achieved by decreasing the diameter of the mandrel while keeping constant the diameter of the billet, the reduction in front of the mandrel nose and in the narrowing of the rolls, the advance of the mandrel beyond the narrowing, and the coefficient of ovalization. The wall of the shell here is slightly thickened. With a decrease in the mandrel diameter (the other parameters are constant) the angle between the axis of the billet-shell and the directional force σ_1 is reduced, which leads to a decrease in the axial bending force σ_2–a component of the directional force σ_1 (see figure).

Therefore, with a decrease in the mandrel diameter the axial part of the billet is subjected to smaller radial tensile forces. In addition, with a decrease in the deformation coefficient in the reeler cone of the rolls the exit speed of the metal from the deformation zone is somewhat reduced, and the input speed of the axial advancement of the metal into the piercing cone increases, which in turn leads to a reduction in the number of alternations in the application of forces to the billet being formed, i. e., to a smaller probability of opening a cavity.

Thus with a deterioration in the quality of the initial billet, in the heating of the billet before piercing in adjustment of the mill, etc. the probability of the formation of a cavity in front of the mandrel nose is less when working with small outside diameters on the first piercing mill. This is especially noticeable when rolling tubes with a diameter of 219 mm.

With a decrease in the roll groove of the automatic mill, the outside diameter on the first piercing mill was reduced by a factor of 3.7 (from 16.6 to 4.4%) and the number of tubes which were second class due to inside flaws was reduced to 45.5%. The outside diameter was reduced by a factor of 1.7 (from 11.1 to 6.2%) when rolling tubes with a diameter of 325 mm.

An improvement in the heating of the ingots at the blooming mill, the conversion to heating billets in two furnaces, and the decrease in the outside diameter on the first piercing mill reduced the number of tubes with inside flaws by 40.7% (for comparison we took the average indexes of the first three months and last three months of the second half of 1959).

While investigating the effect of the directional angle of the work rolls on the quality of the inside surface of tubes, we established that for low-carbon tube steels (steel 10 and 20, St. 2, St. 4) a 10-12% change in the directional angle within the limits of 6-9° does not affect the quality of the inside surface of tubes during reduction in the rolls.

145 YEARS OF ZLATOUST ENGRAVING

Translated from Metallurg, No. 2
p. 32, February, 1961

In the middle of December, 1960 the collective of the Lenin Zlatoust Plant noted a famous historical date – 145 years of Zlatoust steel engraving.

This remarkable independent art originated in the beginning of the last century with the organization of the Zlatoust arms factory. The trail-blazer of Russian engraving was the well-known, self-educated Russian artist Ivan Bushuev. The wings of his golden steed grew and they spread the great fame of Damascus steel throughout the world. Here were created the works of the Boyarshinovas, the Telezhnikovs, the Utkins, Agarkovs, and Yakolevs – marvelous Russian skilled masters who added more than one glorious page to the history of the world's engraving. In our time the art of engraving on metal was enriched by new contents, new forms, new technology. "Steel paintings" have come to serve mainly the purposes of embellishing household articles, of satisfying the aesthetic demands of our people. The work of the Zlatoust engravers can now be seen not only in museums and exhibitions, but also in homes of simple people who are able to appreciate this remarkable art.

THE GLORIOUS WORK OF THE TAGIL WORKERS

Translated from Metallurg, No. 2
pp. 33-34, February, 1961

"...The patriotic work of your brigades, who have been awarded the high rank of Collectives of Communist Labor, is an example for metallurgists of the entire country and deserves wide propagation..."

(From N. S. Krushchev's letter to the steel workers of the open-hearth furnaces of the Nizhne-Tagil Metallurgical Combine, Yu. M. Zashlyapin, T. E. Obraztsov, Ya. M. Kal'nichenko, and Yu. P. Ploskonenko, and all workers of the brigades of this furnace. "Pravda", December 27, 1960)

Socialist competition, the wide adoption of the experience of the foremost workers and innovators of the metallurgical enterprises–these are large reserves for increasing the output of pig iron, steel, and rolled products.

The Collective of Communist Labor of the large open-hearth furnace at the Nizhne-Tagil Metallurgical Combine, headed by steel workers Yu. M. Zashlyapin, Yu. P. Ploskonenko, Ya. M. Kal'nichenko, and T. E. Obraztsov, has achieved outstanding successes.

Placing themselves at the head of socialist competition for the prescheduled fulfillment of the Seven-Year Plan and having taken the obligation to achieve by 1963 a production of 12 t of steel per m^2 hearth area, which had planned for by the end of the Seven-Year Plan, the steel workers of this furnace have already attained in 1960 the highest index of the utilization of open-hearth furnaces in the Soviet Union (11.36 t of high-quality steel produced per m^2 of hearth area).

This collective, by skillfully combining excellent labor organization with an extensive use of the most advanced technology, in 1960 produced more than half the melts at high speed and smelted more than 10,000 t of steel in excess of the plan. The productivity of the furnace increased about 5% as compared with that of 1959.

These achievements were attained by the steel workers as a result of the collective work of all brigades of the unit, and they were the first at the combine to win the distinguished right to be called a Collective of Communist Labor. Each member of the collective has the same desire to improve the operation of the furnace and to increase its output. The leaders of the brigades periodically got together, discussed their work, and noted ways for a further efficient utilization of the furnace.

The steel workers mastered and extensively used the new improved technology of large-scale automatic control of the furnace heating conditions. They showed personal interest in the smooth operation of the automatic device, carefully checked the working order of all its units and control and measuring apparatus.

In some cases they eliminated minor disrepairs in the instruments without waiting for a worker from the Control and Measuring Department. Therefore, the automatic device at the furnace operated for an entire year almost without breakdown. Working under conditions of a large-scale automatic control of the heating conditions requires fast and clear fulfillment of all operations.

Steel workers Yu. Zashlyapin, T. Obraztsov, Ya. Kal'nichenko, and Yu. Ploskonenko constantly search for new methods to utilize the unit at a maximum; constantly perfecting their skill, working, and technological meth-

ods they search for the most efficient form of labor organization in the brigades, and thus save time in each operation. In each individual case they post the members of the brigades so that not one minute is lost; they unremittingly strive for a well-timed provisioning of the unit with the charge, ferroalloys,and fetting materials.

The steel workers begin the struggle for high-speed smelting with tapping of the previous melt, during which dressing of the furnace begins. Rapid accomplishment of this operation assures good weldability of the dressing materials. If tapping of the melt coincides with the end of the shift, the brigade finishing work remains to help their comrades fettle the furnace more rapidly,and only after charging the first portion of the charge do they leave the shop.

Charging of loose material is carried out layer by layer: first a uniform layer of sinter so that the limestone charged afterwards does not fall on the bare hearth ; after 5-8 min the ore is added. This assures a uniform heating and rapid melting of the charge. Heavy scraps are charged into the furnace last so as not to change the direction of the flame.

Each fettling of the false baffle plates assures a crust on them by the time the pig iron is charged into the furnace. The use of two cranes to pour pig iron into two spouts favors the intense formation of flowing slag of high basicity and its slagging off of not less than 30 m^3, which assures the best removal of the harmful admixtures and shortens the refinement time.

A shortening in the smelting duration is favored by the correct capacity of the furnace bottom and slag hole. The steel workers during the smelting process save more than 14 min in comparison with other brigades by an efficient and rapid organization of dressing the furnace and the most efficient charging.

The Collective of Communist Labor made wide use of oxygen to intensify smelting. During the entire period of smelting (except charging and refining),air enriched with 23% oxygen was fed to the flame. In addition, oxygen was blown through two mechanized tuyeres to the bath after smelting so as to accelerate the process of direct oxidation of the carbon.

The savings in time in each operation made it possible for the steel-workers in 1960 to produce 53.3% high-speed melts, while the total for the shop during this period was 42.7%.

In comparison with 1959, the Collective of Communist Labor lowered smelting time by 12 min and each melt is now produced in 15 min faster than the average time in the shop.

All brigades at the furnace strive to fully utilize the potentialities of the unit: they constantly search for new means to increase the weight of each melt by correctly using the technological process, by improving maintenance of the unit, and by increasing the weight of the metal charge. A good state of the bath and the false baffle plates will permit an increase in the weight of the charge not by 5, but by 10-13 t. An excellent condition of the slag and steel tapping holes makes it possible to avoid great losses in metal when slagging off and tapping steel. By good and correct heating of the loose material, cases of metal rejects after pouring the pig iron are eliminated.

The collective of the furnace did not have a single case of tapping a cold melt during the recent past.

In 1960 the collective of the furnace increased the weight of the melt as compared with 1959 by an average of 4.2 t and by this alone produced more than 4000 additional tons of steel.

Knowing that accident-free work, maximum utilization, and the service life of the open-hearth furnace depend on proper operation and care, the steelworkers look after their furnace, do not permit disorders in the heating and technological conditions of operation, and watch and take measures for assuring the excellent condition of all parts of the unit.

The working experience of this foremost collective in the care of their unit was widely propagated among other steelworkers of the shop at the school for advanced experience, which is headed by Yu. M. Zashlyapin.

After each charge the steelworkers blow out the top with compressed air, see to the systematic blowing and washing of the air checkers, carefully care for the hearth, slag and steel tapping holes, attentively watch for and systematically repair the gas bays and columns of the front wall of the furnace, and regularly smear them with a special refractory mass. The entire collective looks after the cleanliness in the control panel room, in the furnace bay, and in the teeming area. Each brigade considers it its duty to leave the shift in exemplary order.

Careful care of the furnace permitted the collective to considerably reduce the time for hot repairs and to increase the run of the furnace. Hot idle times for repair were reduced in 1960 as compared with 1959 by 0.7% and was 3.6%, while the average for the shop for hot repair was 4.1% of the calendar time. Repair time for the hearth was also reduced. This furnace was stopped for repair of the hearth 0.79% of the calendar time, while the average for the shop for the repair of the hearth was 0.89% of the time.

The lowering of melt time, the increase in its weight, the decrease in hot idle times, and greater time between repair periods due to proper operation and good care of the furnace–all this permitted the brigades of the leading open-hearth furnace to produce almost 2 tons/hr more than produced by steelworkers at other furnaces of the shop.

The Collective of Communist Labor during the last two years compiled an annual plan for the introduction of new techniques and progressive technology at the furnace. From their initiative, for example, the "Shvir" valve system in the air line was replaced by a gate valve which improved the heating conditions of the furnace; equipment was installed for blowing oxygen through the molten bath and also the oxygen line diameter was increased to 130 mm for a uniform pressure of the oxygen.

The collective of the furnace actively participated in taking measures to introduce new techniques and progressive technology. For example, a boiler utilizer for a pressure of 45 atm (gage) was installed at the furnace.

The Collective of Communist Labor with the help of the engineering and technical workers of the shop has recently introduced many valuable suggestions for efficiency. In particular, according to the suggestions of the shop's efficiency experts, a tuyere embrasure was installed on the furnace in order to measure the temperature of the furnace top; and also the control system of the flue valves was improved. The hoists of the tripping system were changed from sliding bearings to roller bearings, a device to automatically switch on the pumps water cooling the top tuyeres was introduced, and the duration of cutting off the carburator when tripping the valves was increased.

Yu. M. Zashlyapin, member of the Collective of Communist Labor, worked out a new composition for dressing the side slopes and front and rear walls of the open-hearth furnace. This suggestion produced a savings of more than 22,500 rubles at the enterprise.

The innovators constantly increased their general-educational, industrial and technical, and cultural levels. Each member of the collective has worked out a personal plan for increasing his industrial and technical and cultural level during the Seven-Year Plan. Many steelworkers and assistants study at the school of the working youth, some at the school of skilled workers and study preparatory courses for entrance to the institute.

The members of the Collective of Communist Labor patronize the school; they help the students master metallurgy, they organize and conduct excursions throughout the shop and combine.

The strong friendship between the members of the brigades also favors clear-cut, harmonious work at the furnace. One can frequently find them at the theater, movies, or factory Home of Culture together.

So lives and works this foremost collective.

DRAWING WIRE ROD FROM BESSEMER METAL

A. M. Bichich

Deputy Chief of the Technical Department of the "Krasnyi Profintern" Plant
Translated from Metallurg, No. 2
pp. 35-37, February, 1961

At our plant we investigated drawing of rolled Bessemer wire rod and compared its properties with open-hearth wire rod OM.

The investigations were carried out in the following order:

1) We determined the number and causes of breaks when drawing over given pass sequences;

2) We tested the wire rod and wire from Bessemer and open-hearth steel after each block for mechanical properties (tensile strength, elongation, reduction of area, bend number);

3) We determined the chemical composition of the metal of the wire rod;

4) We carried out metallographic investigations of the wire rod and the finished wire.

For the investigation we took BSt. O wire rod of the Dzerzhinskii Plant, BSt. 3 of the Petrovskii and Komintern Plants, and OM of the Dzerzhinskii and Komintern Plants.

The Bessemer wire rod was pickled according to the established technology (the duration of pickling was 20-30% less than for open-hearth wire rod).

Then the wire rod was rinsed with cold tap water and limed in a boiling solution of lime.

The basic data of the investigation are shown in Table 1.

The effect of the amount of reduction on drawing of Bessemer wire rod is shown in Table 2, which also includes the value of the mean breakages per ton of metal for each drawing sequence. We used the data of table 1 in calcinating the breakage.

It is apparent from Table 2 that breakage in the wire rod decreases with a decrease in reduction.

The breakage was reduced by a factor of $3.4/0.8 = 4.25$ for a final diameter of 4.5 mm with an increase in the number of draws from two to three. The breakage was reduced by a factor of $4.5/2 = 2.25$ with an increase in the number of draws from two to three for a final diameter of 4.0 mm and by a factor of 1.2 for a diameter of 3.5 mm.

Observations showed that the smaller the final diameter of the wire, the less the effect from decreasing the reduction for Bessemer wire rod.

The breakage of open-hearth and Bessemer wire rod is compared in Table 3. It is apparent from the table that the breakage per ton increases for Bessemer metal in comparison with open-hearth metal during drawing:

To diameter,	5.0 mm	by	$1.8-0.25=1.6$	Breaks per 1 ton
" "	4.5 "	"	$3.4-1.0=2.4$	" "
" "	4.0 "	"	$4.5-1.6=2.9$	" "
" "	3.5 "	"	$8.5-1.4=7.1$	" "

Drawing of open-hearth wire rod down to a diameter of 5 mm occurs almost without breaks, while drawing of Bessemer metal produces about 2 breaks per ton.

When drawing Bessemer wire rod to diameters of 4.5 and 4.0 mm with smaller reductions, about the same or slightly more breaks occur than when drawing open-hearth wire rod to these same dimensions by using the normal reductions.

Drawing of Bessemer wire rod to a diameter of 3.5 mm is accompanied by a greater number of breaks when using both the normal and smaller reductions.

TABLE 1

Conditions of Drawing and Breakage of Open-Hearth and Bessemer Wire Rod

Starting diameter, mm	Final diameter, mm	Number of draws	Reduction, %	Equipment	Drawing speed, m/min	Drawing angle, deg	Metal	Metal drawn, t	Number of breaks	Number of breaks/ton finished product
6.5	5.0	2	19.5—30.0	Braidenbakh 2/600	210	12	Open-hearth	5.35	1	0.2
6.5	5.0	2	19.5—30.0	same	210	12	Bessemer	13.23	21	1.6
6.5	5.0	2	19.5—30.0	» »	210	10	same	3.10	3	1.0
6.5	5.0	2	19.5—30.0	» »	210	8	» »	1.10	4	3.6
6.5	4.5	2	30.0—34.2	» »	210	12	Open-hearth	3.90	4	1.0
6.5	4.5	2	30.0—34.2	» »	210	12	Bessemer	9.35	33	3.5
6.5	4.5	3	19.5—24.2—22.6	5/600	182	12	same	2.40	2	0.8
6.5	4.0	2	39.5—38.2	same	182	12	Open-hearth	13.6	22	1.6
6.5	4.0	2	39.5—38.2	» »	182	12	Bessemer	1.75	10	5.7
6.5	4.0	2	39.5—38.2	» »	182	10	same	0.70	2	3.0
6.5	4.0	2	39.5—38.2	» »	182	8	» »	3.10	15	4.3
6.5	4.0	3	21.0—31.5—31.0	Krantos 3/600	170	12	Bessemer	10.35	27	2.6
6.5	4.0	3	21.0—31.5—31.0	same	170	8	same	1.80	1	0.55
6.5	3.5	3	33.3—33.2—35.8	Krantos 3/560	275	12	Open-hearth	5.10	7	1.4
6.5	3.5	3	33.3—33.2—35.8	Braidenbakh 5/600	260	12	Bessemer	1.00	10	10.0
6.5	3.5	3	38.3—33.2—35.8	Krantos 3/600	170	12	same	0.90	9	10.0
6.5	3.5	3	38.3—33.2—35.8	same	170	12		1.40	9	6.4
6.5	2.5	5	37.0—36.5—27.0—29.0—27.0	Mal'medi 5/600	280	10	Open-hearth	1.5	2	1.33
Annealed* 2.5	2.5	4	26.0—26.8—28.4—24.0	same	280	10	Bessemer	3.40	15	4.4
Annealed* 2.5	1.0	7	18.8—21.2—26.2—23.8—25.0—23.1—23.0	Mal'medi 7/315	285	10	same	0.50	20	40.0

* Lubricant-pure soap powder. In all other cases the lubricant is soap powder with 18% talc.

TABLE 2

Mean Indexes on Breakage of Wire Rod from Bessemer Metal with Different Reductions. (Starting Diameter 6.6 mm)

Final Diameter, mm	Number of draws	No. of breaks per ton of wire
4.5	2	3.4
4.5	3	0.8
4.0	2	4.5
4.0	3	2.0
3.5	3	8.5
3.5	4	7.15

TABLE 3

Mean Indexes on Breakage of Open-Hearth and Bessemer Wire Rod (Starting Diameter 6.6 mm)

Final diameter, mm	Number of draws	Breakage per ton of wire rod	
		Open-hearth	Bessemer
5.0	2	0.2	1.8
4.5	2	1	3.4
4.5	3	not found	0.8
4.0	2	1.6	4.5
4.0	3	not found	2.0
3.5	3	1.4	8.5
3.5	4	not found	7.5

Satisfactory results were achieved when drawing Bessemer steel only to a diameter not less than 4.0 mm, and then only if smaller reductions and an increased number of draws were used.

In order to check the possibility of drawing thinner Bessemer wire rod, drawing to a diameter of 3.5 mm was done at a slower speed (170 m/min instead of the usual 275 m/min). The number of breaks per ton in this case was 7.85, i. e. , the same as at the usual speed with normal and smaller reductions.

In order to produce a thinner wire, we attempted to draw Bessemer wire from a diameter of 5.0 mm down to 2.5 mm after annealing. Open-hearth wire with a diameter of 2.5 mm was obtained usually by drawing directly from the wire rod.

In order to produce a Bessemer wire with a diameter of 2.5 mm, a 5 mm diameter wire was annealed and then drawn to the required diameter. Drawing was accompanied by rather high breakage (4.4 breaks/ton), while about 1.3 breaks/ton occured when drawing open-hearth wire down to a diameter of 2.5 mm directly from wire rod.

In spite of introducing the expensive operation of annealing and the additional drawing from a diameter of 6.5 mm, drawing of Bessemer metal to a diameter of 2.5 mm is accompanied by high breakage and is uneconomical in comparison with drawing open-hearth wire rod to the same dimension. In addition, annealing is a bottleneck at the plant and therefore cannot assure the required amount of wire.

During the study we also investigated drawing of annealed Bessemer wire from a diameter of 2.5 mm down to 1.0 mm. In this case we detected an extremely high breakage (40 breaks/ton), whereby the breaks were on all blocks.

Drawing of open-hearth wire under mass-production conditions is done from annealed wire from a diameter of 2.8 mm down to a diameter of 1.0 mm and even to 0.9 mm, and not more than five breaks/ton are observed.

During the analysis we established a higher breakage of Bessemer metal in comparison with open-hearth metal. This is due mainly to the increased contamination, heterogeneity, segregation, and lower ductility of Bessemer metal.

Since wire rod for general-purpose wire does not come from the metallurgical plants from the same heats, we selected test specimens for the chemical analysis from three coils.

The results of the chemical analysis for all specimens were within the limits of All-Union State Standard 380-50.

TABLE 4

Results of Testing the Mechanical Properties of Wire Rod

Tensile strength, kg/mm^2	Elongation, %	Reduction of area, %	Bend number
Open-hearth wire rod			
37.6	22.5	70.7	22
36.6	30.0	48.0	14
40.3	30.0	42.8	17
38.3	41.1	60.0	13
Bessemer wire rod			
43.9	20	62.0	14
43.7	20	41.3	6
46.2	16	38.6	8
47.5	25	41.3	16
40.7	30	75.2	12
40.3	20	43.8	9
46.4	25	39.2	11
44.0	25	25.9	12
39.7	30	44.3	13

The specimens of the initial wire rod and wire were selected after each block and mechanical testing was carried out (tensile strength, elongation, reduction of area, and bend number, Table 4).

The mechanical tests of the wire rod showed that in the majority of cases the tensile strength was greater for Bessemer metal than for open-hearth metal, and elongation, reduction of area, and the bend number on the other hand, was less. Wire of Bessemer metal differs from wire rod of open-hearth by greater flexibility, brittleness, and lower ductility.

For the metallographic investigation we selected specimens of the initial wire rod and finished wire, from which we investigated and photographed the micro- and macrostructure longitudinally and transversely.

These investigations were not sufficiently detailed. However, they showed a marked segregation, especially toward the longitudinal axis in Bessemer metal. In addition, we established that during the drawing process nonmetallic inclusions of a manganese sulfide type are also detected.

While drawing Bessemer wire rod we observed high breakage due to the contamination and low ductility of the metal, which leads to metal losses and reduction in the output of wire rod as compared with open-hearth rod.

When breakage for Bessemer wire rod is slightly more than for open-hearth wire rod, it can be drawn down to a diameter of 5.0 mm by using the existing drawing sequence on the two-stage mill.

It is expedient to draw Bessemer metal to a diameter of 4.0 mm only in three stages. When drawing to smaller dimensions breakage is extremely high (7-8 breaks/ton) already at a diameter of 3.5 mm, as a consequence of which productivity is reduced by 30-35% in comparison with drawing open-hearth wire rod, and metal losses are increased. Neither a smaller reduction nor a decrease in the speed yield poitive results when drawing Bessemer wire rod to a diameter of 3.5 mm.

This study showed that drawing Bessemer metal to a diameter smaller than 4.0 mm cannot be recommended.

INCREASED PRODUCTION OF CZECHOSLOVAK METALLURGY

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May 9, 1961 is the 16th anniversary of the Soviet Army liberation of Czechoslovakia from Nazi occupation. Since this time the economy of the country has been increased to a high level. Czechoslovakia is now one of the most powerful industrial countries in the world.

Increasing the output of the Czechoslovak metallurgical industry was not an easy problem, since the economy was seriously disrupted during the war and the metallurgical concerns worked for the German war industry. The technical level of the nationalized metallurgical industry was low, and the production capacities were insufficient. The metallurgical industry could not satisfy the requirements of all branches of the national economy, especially chemical industry, engineering, and the building and fuel industries.

Nevertheless, as soon as the war had finished, the Czechoslovak metallurgists enthusiastically began improvements. Due to the activity of all workers in the first year after the war the dusrupted economy was completely restored: in 1946 about 1 million tons of iron was smelted, 1.6 million tons of steel, 1.2 million tons of rolled stock was produced, and in 1947 the metallurgical industry achieved the prewar level of production: 1.675 million tons of iron, 2.300 million tons of steel, 1.557 million tons of rolled steel.

Taking advantage of experience in the Soviet Union it was concluded that to build a Socialism in Czechoslovakia, the plants which had been nationalized after 1945 would not be sufficient. Thus the total volume of blast furnaces in Czechoslovakia was only 6240 m^3 and the volume of the largest blast furnace was 700 m^3. A large part of the steel was smelted in small capacity open-hearth furnaces (maximum 250 tons). The rolling mills were also equipped with old low-productivity equipment at a low stage of mechanization. Czechoslovak metallurgy could, therefore, only be developed by redesigning old units and building new units and complete metallurgical plants. In 1958 investments in the development of the metallurgical industry were 2 billion krona and in 1959, 2.6 billion krona. During this time 11 coke ovens were built with a total capacity of 3.8 million tons/year, 9 blast furnaces with total capacity of more then 2.5 million tons iron per year, and 16 new open-hearth furnaces with a total capacity of 2.54 million tons of steel per year.

The development of production in the Czechoslovak metallurgical plants after 1950 is shown below (the production of 1937 is taken as 100%), %:

Years	1950	1955	1957	1959	1960 (plan)
Iron	116	178	213	253	282
Steel	136	195	224	267	298
Rolled stock	136	190	221	258	293

It can be seen from these figures that in 1960 about three times more metal was produced than in 1937.

The most serious redesigning difficulties were encountered in the conversion of rolling mills which had to be rebuilt to fulfill the requirements of all branches of the national economy. Two blooming mills were built

with an output of 1.2 million tons/year each. Two blooming mills were redesigned and their production increased by 80 thousand tons/year. Between 1945 and 1960 (the start of the year) the following mills were built :

a) 10 merchant and sheet mills of total capacity 2.475 million tons /year;

b) 3 pipe rolling mills of total capacity 145 thousand tons/year;

c) 2 cold rolling strip mills of total capacity 160 thousand tons/year;

d) 1 hot rolling strip mill;

e) 1 wire mill

The prewar Czechoslovak metallurgical industry operated mainly with imported ferroalloys; only very small amounts of ferrosilicon, ferrochromium, and ferrovanadium were home produced. This position existed before the start of the first Czechoslovak ferroalloy plant in 1952. The plant cost 260 million krona. Soviet specialists were very helpful in equipping and starting up the plant. In 1952 one 3000 kw furnace was started, and then other 3-phase furnaces with 82 thousand kw total power were started. The increase in production of ferroalloys at this plant is given below (the 1953 production is taken as 100%), % :

Years	1953	1954	1955	1956	1957	1958	1959
Production of Ferroalloys	100	130	156	274	395	400	480

The plant now produces practically all the main ferroalloys for the production of high-grade and carbon steels.

Relating the construction work with the present day positions it can be stated that considerable successes have been achieved in the whole of the national economy during the 15 years. By equipping new units Czechoslovak matallurgy in 1959 produced 4.3 million tons of iron 5.6 million tons of steel, and 4.2 million tons of rolled stock. The production of steel per head of population reached 450 kg; in terms of this index Czechoslovakia occupies the seventh position in the world.

The Modern State and Technical Level of Metallurgical Plants.

The average volume of modern Czech blast furnaces is about 660 m^3. The smallest furnace is 240 m^3, the largest, 1160 m^3. At many of the furnaces the work is mechanized and in the near future their automation will be commenced. Of the blast furnaces operating in Czechoslovakia three operate with increased gas pressure in the upper cylindrical portion. The iron content in the blast furnce charge in 1959 averaged 39% throughout the country; the consumption of sinter for 1 ton of iron was about 880 kg. The coke consumption was therefore fairly high and was 1018 kg/ton; the average coefficient of utilization of useful volume throughout the country was 0.97. The slag yield is 1050 kg/ton iron. blast temperature 650°. and its consumption 2800 m^3/ton iron.

There are now 76 open-hearth furnaces operating in Czechoslovakia with an average hearth area of about 35 m^2. The capacity of the smallest furnaces is 5 tons the largest (rocking furnace) is 400 tons. Of the total steel production in 1960 the largest part (6.8 million tons) was produced in open-hearth furnaces. A total of 250 thousand tons was smelted in basic bessemer converters and 800 thousand tons of steel in electric furnaces. Czechoslovakia has rich deposits of magnesite and has a well-developed refractory industry. In this connection about 80% of the furnaces are equipped with basic roofs (magnesite chrome or chrome magnesite).

The yield of steel from 1 m^2 of hearth area of open-hearth furnaces in 1959 was 5.84 tons/day with an average fuel consumption of 1.265 million kcal for 1 ton of steel.

At the present time oxygen is used in one open-hearth department where commercial steels are smelted; oxygen is used to a lesser extent in the open-hearth department smelting only high-grade steel. The total production of killed steel is 45%, rimmed steel 55%.

Most of the open-hearth furnaces are fueled with mixed gas and carburated with fuel oil. Only a small number of furnaces are fueled with generator gas or fuel oil. There is one installation for the vacuum pouring of steel and a continuous casting installation.

In 1960, 4.6 million tons of rolled stock was produced. The types of rolled production in this year were the same as in 1958, %:

Sheets	24.6
Steel pipes	13.8
including welded pipes	2.1
Section steel and strip	61.6

Most of the steel and rolled stock in Czechoslovakia is produced at the Klement Gottwald "Nova Huta" Metallurgical Combine in Ostrava-Kunchitsakh, the construction of which was started after 1948. The first units of this large combine were put into operation at the start of 1952. Less than three years from the start of construction-the first fully integrated steel plant started production. Before the end of the first Five,Year Plan the operating units included 4 coke ovens, 2 blast furnaces, 3 sintering machines, 4 open-hearth furnaces and a lime plant, blooming mill with billet mill, pipe rolling and other mills.

In the years of the second Five-Year Plan the main emphasis was on increasing the capacity of rolling mills; in addition another 2 blast furnaces were built, then four 400-ton rocking open-hearth furnaces, coke ovens and auxiliary mills.

Possibilities for Development in Czech Metallurgy

The rate of development in the metallurgical industry achieved during the last 10 years will be still further increased between 1961 and 1965. According to statements of the Central Committee of the Czech Communist Party and the Czech Goverment in 1965, the production of coke will be 11.3 million tons, iron 7.65 million tons, steel 10.5 million tons, and rolled stock 7.3 million tons (excluding 0.88 million tons of pipes). The coefficient of utilization of useful volume of the blast furnaces will be improved to 0.75 and the consumption of dry coke will be reduced to 717 kg/ton iron. To achieve this the preparation of home-produced and imported ores will be improved before charging into the blast furnace. There will also be considerable increases in the production of sinter, which will reach 13 million tons in 1965. The blast temperature will be increased to 900° Some blast furnaces will be converted to high pressure in the upper cylindrical portion (up to 1.4 atm).

As already mentioned, the production of steel will be about 10.5 million tons, i. e. 92% higher than in 1958. This figure will be achieved by intensifying the production process, introducting new techniques, redesigning units, and also by building new mills and furnaces. Of the total steel production in 1965 about 3.36 million tons will be smelted in the new units.

Whereas in 1958 the proportion of individual processes in steel smelting production was, %:

Basic bessemer conversion	3.8
Open-hearth process	83.1
Electric smelting	13.1,

in 1965 the proportion of the separate processes will be, %:

Basic bessemer conversion	2.4
Open-hearth process	70
Electric smelting	13.4
Oxygen converter process	14.2

It can be seen from these figures that in the next 5 years the predominant process will be the open-hearth process, although its fraction of the total production will be reduced. By the end of the third Five-Year Plan the new process of providing steel in oxygen converters will be adopted (at two plants). The production of electric steel will increase in proportion to the increase in volume of steel production, so that as a percentage it will not change appreciably. The absolute volume of basic bessemer steel will not change.

Since the fraction of steel produced in open-hearth furnaces of the total smelting will be rather high, this process will have the greatest fraction of increase in steel production, i. e., 1.88 million tons of the total increase of 3.8 million tons. This increase in steel production in open-hearth furnaces will mainly be achieved by reducing

lost time on overhauls, using oxygen and fuel oil for firing, redesigning existing furnaces and increasing their capacity and modernization (for example, using Merz-Bellens type heads), improving the quality of charge materials, and organizing the work.

Of the total increase in steel production the reduction in lost time for overhauls will account for about 11%, the use of oxygen and oil about 15%, the redesigning of furnaces about 14%, and improvements in the charge quality about 7%. At existing furnaces the increase in productivity will be 45%. Most of the increased smelting (55%) will come from the new steel smelting mills.

The introduction of new production process and technological innovations will considerably improve the technical and economic indices of steel production in open-hearth furnaces compared with countries having a well-developed metallurgical industry. Whereas in 1958 the furnace lost time was 5% higher than in the USSR, in 1955 this figure will only be 2%. The yield of steel from 1 m^2 of hearth area in department with 200-ton furnaces will reach 10.36 tons (at present it is 6.1 tons). The consumption of heat per ton of steel will be reduced by 10%.

To increase the technical and economic indices of steel production in Czechoslovakia, apart from the measures mentioned, continuous casting of steel will also be introduced, which will make it possible to increase the yield of useful steel and facilitate operation in the casting bay. In addition to increasing production volume, it should also increase the quality of the metal and technological innovations to be introduced. For example, the vacuum casting of high duty steels for large forging ingots will increase the quality and reduce the time for producing the steel. Special steels and alloys will be smeltered in vacuum furnaces with an expendable electrode, which will make it possible to achieve the highest possible quality in these materials. To increase the yield of useful steel from ingots, exothermic mixtures and hot-tops will be introduced.

New types of steel will be produced to satisfy the requirements of the engineering industry; this will make it possible to redesign the heavy industry and introduce new techniques. Weldable construction steels will be produced with a tensile strength greater than 40 kg/mm^2. For reinforced concrete structures, steel will be produced with tensile strengths of 40 and 60 kg/mm^2. High-alloy steels and alloys will be used to make components which can increase the working temperatures at steam heating plants to 650°. For the succsessful development of the automobile industry they will produce high tensile steel with high plastic properties, which will permit considerable reductions in the weight of light automobiles.

By fulfiling the problems of the third Five-Year Plan, Czechoslovakia will overtake such countries as Britain and West Germany in the production of steel per unit of population, and in 1965 will approach the level in the USA.

The production will be organized of alloys which have until now not been smelted in Czechoslovakia, for example, complex deoxidants CaSiMn, CaSiAl, and some 4-component deoxidants. The production of low-alloy anticorrosion steel with less than 0.03% C requires the production of ferrochromium containing less than 0.02% C. Furthermore, the methods of ferroalloy production will be improved; multistage processes will be replaced by new processes with fewer stages or with single stages.

In the third Five-Year Plan a 1280 five-stand cold-rolling mill will be put into operation and a 1680 continuous wide-strip hot-rolling mill, which will considerably improve the supply of thin sheet to the national economy. Transformer and dynamo strip will be rolled on a 1280 four-high stand. These rolling mills will make it possible to organize the mass production of welded tubes and bent profiles and also metal for deep drawing. In addition to the new plant for the production of steel pipes of up to 130 mm diameter, mills will be built for the production of pipes by resistance welding with diameters up to 500 mm and mills for spiral welding of pipes of up to 400 mm diameter. The diameter of seamless pipes will be increased to 720 mm.

The successes of Czech metallurgists during the last 15½ years have brought Czechoslovakia into line with the most developed countries of the world. The guarantee of this success is the labor not only of workers, technicians, and engineers of the metallurgical plants, but also the workers of all branches of the national economy. There is no doubt that the industrious Czech nation will use all its energies for the further growth of the metallurgical industry and the continued increase in living and cultural standards of the workers.

Soviet Journals Available in Cover-to-Cover Translation

ABBREVIATION	RUSSIAN TITLE	TITLE OF TRANSLATION	PUBLISHER	TRANSLATION BEGAN Vol.	Issue	Year
AÉ	Atomnaya énergiya	Soviet Journal of Atomic Energy	Consultants Bureau	1	1	1956
Akust. zh.	Akusticheskii zhurnal	Soviet Physics – Acoustics	American Institute of Physics	1	1	1955
	Antibiotiki	Antibiotics	Consultants Bureau	4	1	1959
Astr(on). zh(urn).	Astronomicheskii zhurnal	Soviet Astronomy–AJ	American Institute of Physics	34	1	1957
Avto(mat). svarka	Avtomaticheskaya svarka	Automatic Welding	British Welding Research Association (London)		1	1959
	Avtomatika i Telemekhanika	Automation and Remote Control	Instrument Society of America	27	1	1956
	Biofizika	Biophysics	National Institutes of Health*		1	1957
	Biokhimiya	Biochemistry	Consultants Bureau	21	1	1956
Byull. éksp(erim). biol. i med.	Byulleten' éksperimental'noi biologii i meditsiny	Bulletin of Experimental Biology and Medicine	Consultants Bureau	41	1	1959
DAN (SSSR) Dokl(ady) AN SSSR	Doklady Akademii Nauk SSSR	The translation of this journal is published in sections, as follows:				
	Life Sciences	Doklady Biochemistry Section	American Institute of Biological Sciences	106	1	1956
	Life Sciences	Doklady Biological Sciences Sections (Includes: Anatomy, biophysics, cytology, ecology, embryology, endocrinology, evolutionary morphology, genetics, histology, hydrobiology microbiology, morphology, parasitology, physiology, zoology sections)	American Institute of Biological Sciences	112	1	1957
	Life Sciences	Doklady Botanical Sciences Sections (Includes: Botany, phytopathology, plant anatomy, plant ecology, plant embryology, plant physiology, plant morphology sections)	American Institute of Biological Sciences	112	1	1957
	Chemical Sciences	Proceedings of the Academy of Sciences of the USSR, Section: Chemical Technology	Consultants Bureau	106	1	1956
	Chemical Sciences	Proceedings of the Academy of Sciences of the USSR, Section: Chemistry	Consultants Bureau	106	1	1956
	Chemical Sciences	Proceedings of the Academy of Sciences of the USSR, Section: Physical Chemistry	Consultants Bureau	112	1	1957
	Earth Sciences	Doklady Earth Sciences Sections (Includes: Geochemistry, geology, geophysics, hydrogeology, mineralogy, paleontology, petrography, permafrost sections)	American Geological Institute	124	1	1959
	Earth Sciences	Proceedings of the Academy of Sciences of the USSR, Section: Geochemistry	Consultants Bureau	106-123	1 6	1957-1958
	Earth Sciences	Proceedings of the Academy of Sciences of the USSR, Sections: Geology	Consultants Bureau	106-123	1 6	1957-1958
	Mathematics	Doklady Soviet Mathematics	The American Mathematics Society	131	1	1961
	Physics	Soviet Physics–Doklady (Includes: Aerodynamics, astronomy, crystallography, cybernetics and control theory, electrical engineering, energetics, fluid mechanics, heat engineering, hydraulics, mathematical physics, mechanics, physics, technical physics, theory of elasticity sections)	American Institute of Physics	106	1	1956
	Physics	Proceedings of the Academy of Sciences of the USSR, Applied Physics Sections (does not include mathematical physics or physics sections)	Consultants Bureau	106-117	1	1956-1957
Derevoobrabat. prom-st'.	Derevoobrabatyvayushchaya promyshlennost'	Wood Processing Industry	Timber Development Association (London)		9	1959
	Élecktrosvyaz	Telecommunications	Massachusetts Institute of Technology*		1	1957
Éntom(ol). oboz(renie)	Éntomologicheskoe obozrenie	Entomological Review	American Institute of Biological Sciences	38	1	1959
Farmakol. (i) toksikol(ogiya)	Farmakologiya i toksikologiya	Pharmacology and Toxicology	Consultants Bureau	20	1	1957
FMM	Fizika metallov i metallovedenie	Physics of Metals and Metallography	Acta Metallurgica*	5	1	1957
Fiziol. zhurn. SSSR (im. Sechenova)	Fiziologicheskii zhurnal im. I. M. Sechenova	Sechenov Physiological Journal USSR	National Institutes of Health*		1	1957
Fiziol(ogiya) rast.	Fiziologiya rastenii	Plant Physiology	American Institute of Biological Sciences	4	1	1957
	Geokhimiya	Geochemistry	The Geochemical Society		1	1958
FTT	Fizika tverdogo tela	Soviet Physics–Solid State	American Institute of Physics	1	1	1959
Izmerit. tekh(nika)	Izmeritel'naya tekhnika	Measurement Techniques	Instrument Society of America		1	1959
Izv. AN SSSR, O(td). Kh(im). N(auk)	Izvestiya Akademii Nauk SSSR: Otdelenie khimicheskikh nauk	Bulletin of the Academy of Sciences of the USSR: Division of Chemical Sciences	Consultants Bureau		1	1952

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Izv. AN SSSR Ser. fiz(ich).	Izvestiya Akademii Nauk SSSR: Seriya fizicheskaya	Bulletin of the Academy of Sciences of the USSR: Physical Series	Columbia Technical Translations		1	1954
Izv. AN SSSR Ser. geofiz.	Izvestiya Akademii Nauk SSSR: Seriya geofizicheskaya	Bulletin (Izvestiya) of the Academy of Sciences USSR: Geophysics Series	American Geophysical Union		1	1954
Izv. AN SSSR Ser. geol.	Izvestiya Akademii Nauk SSSR: Seriya geologicheskaya	Izvestiya of the Academy of Sciences of the USSR: Geologic Series	American Geological Institute		1	1958
Kauch. i rez.	Kauchuk i rezina	Soviet Rubber Technology	Research Association of British Rubber Manufacturers	18	1	1959
	Kinetika i kataliz	Kinetics and Catalysis	Consultants Bureau	1	3	1960
	Koks i khimiya	Coke and Chemistry USSR	Coal Tar Research Association (Leeds, England)		1	1958
Kolloidn. zh(urn).	Kolloidnyi zhurnal	Colloid Journal	Consultants Bureau	14	1	1952
	Kristallografiya	Soviet Physics – Crystallography	American Institute of Physics	2	1	1957
Metalov. i term. obrabot. metal.	Metallovedenie i termicheskaya obrabotka metallov	Metal Science and Heat Treatment of Metals	Acta Metallurgica	6	1	1958
	Metallurg	Metallurgist	Acta Metallurgica		1	1957
Met. i top.	Metallurgiya i topliva	Russian Metallurgy and Fuels	Eagle Technical Publications		1	1960
Mikrobiol.	Mikrobiologiya	Microbiology	American Institute of Biological Sciences	26	1	1957
OS	Optika i spektroskopiya	Optics and Spectroscopy	American Institute of Physics		6	1959
	Pochvovedenie	Soviet Soil Science	American Institute of Biological Sciences		1	1958
	Priborostroenie	Instrument Construction	British Scientific Instrument Research Association		1	1959
Pribory i tekhn. éks(perimenta)	Pribory i tekhnika éksperimenta	Instruments and Experimental Techniques	Instrument Society of America		1	1957
Prikl. matem. i mekh.	Prikladnaya matematika i mekhanika	Applied Mathematics and Mechanics	American Society of Mechanical Engineers		1	1958
PTÉ	(see Pribory i tekhn. éks.)					
	Problemy Severa	Problems of the North	National Research Council of Canada			
Radiotekh.	Radiotekhnika	Radio Engineering	Massachusetts Institute of Technology*	12	1	1957
Radiotekh. i élektronika	Radiotekhnika i élektronika	Radio Engineering and Electronics	Massachusetts Institute of Technology*	2	1	1957
	Stanki i instrument	Machines and Tooling	Production Engineering Research Assoc.		1	1959
	Stal'	Stal (in English)	Iron and Steel Institute		1	1959
Stek. i keram.	Steklo i keramika	Glass and Ceramics	Consultants Bureau	13	1	1956
Svaroch. proiz-vo	Svarochnoe proizvodstvo	Welding Production	British Welding Research Association		4	1959
Teor. veroyat. i prim.	Teoriya veroyatnostei i ee primenenie	Theory of Probability and Its Applications	Society for Industrial and Applied Mathematics		1	1956
Tsvet. Metally	Tsvetnye metally	Nonferrous Metals	Primary Sources		1	1960
UFN	Uspekhi fizicheskikh Nauk	Soviet Physics – Uspekhi (partial translation)	American Institute of Physics	66	1	1958
UKh	Uspekhi khimii	Russian Chemical Reviews	The Chemical Society (London)		1	1960
UMN	Uspekhi matematicheskikh nauk	Russian Mathematical Surveys	London Mathematical Society	15	1	1960
Usp. fiz. nauk	(see UFN)					
Usp. khim(ii)	(see UKh)					
Usp. matem. nauk	(see UMN)					
Usp. sovr. biol.	Uspekhi sovremennoi biologii	Russian Review of Biology	Oliver and Boyd		48	1959
Vest. mashinostroeniya	Vestnik mashinostroeniya	Russian Engineering Journal	Production Engineering Research Assoc.		4	1959
Vop. gem. i per. krovi	Voprosy gematologii i perelivaniya krovi	Problems of Hematology and Blood Transfusion	National Institutes of Health*		1	1957
Vop. onk.	Voprosy onkologii	Problems of Oncology	National Institutes of Health*		1	1957
Vop. virusol.	Voprosy virusologii	Problems of Virology	National Institutes of Health*		1	1957
Zav(odsk). lab(oratoriya)	Zavodskaya laboratoriya	Industrial Laboratory	Instrument Society of America	25	1	1959
ZhAKh Zh. anal(it). khimii	Zhurnal analiticheskoi khimii	Journal of Analytical Chemistry USSR	Consultants Bureau	7	1	1952
ZhETF Zh. éksperim. i teor. fiz.	Zhurnal éksperimental'noi i theoreticheskoi fiziki	Soviet Physics–JETP	American Institute of Physics	28	1	1955
ZhFKh Zh. fiz. khimii	Zhurnal fizicheskoi khimii	Russian Journal of Physical Chemistry	The Chemical Society (London)		7	1959
ZhMÉI Zh(urn). mikrobiol. épidemiol. i immunobiol.	Zhurnal mikrobiologii, épidemiologii i immunobiologii	Journal of Microbiology, Epidemiology and Immunobiology	National Institutes of Health*		1	1957
ZhNKh Zh(urn). neorgan(ich). khim(ii)	Zhurnal neorganicheskoi khimii	The Russian Journal of Inorganic Chemistry	The Chemical Society (London)		1	1959
ZhOKh Zh(urn). obshch(ei) khimii	Zhurnal obshchei khimii	Journal of General Chemistry USSR	Consultants Bureau	19	1	1949
ZhPKh Zh(urn). prikl. khimii	Zhurnal prikladnoi khimii	Journal of Applied Chemistry USSR	Consultants Bureau	23	1	1950
ZhSKh Zh(urn). strukt. khimii	Zhurnal strukturnoi khimii	Journal of Structural Chemistry	Consultants Bureau	1	1	1960
ZhTF Zh(urn). tekhn. fiz.	Zhurnal teknicheskoi fiziki	Soviet Physics–Technical Physics	American Institute of Physics	26	1	1956
Zh(urn). vyssh. nervn. deyat. (im. Pavlova)	Zhurnal vysshei nervnoi deyatel'nosti (im. I. P. Pavlova)	Pavlov Journal of Higher Nervous Activity	National Institutes of Health*		1	1958

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SIGNIFICANCE OF ABBREVIATIONS MOST FREQUENTLY ENCOUNTERED IN SOVIET PERIODICALS

FIAN	Phys. Inst. Acad. Sci. USSR.
GDI	Water Power Inst.
GITI	State Sci.-Tech. Press
GITTL	State Tech. and Theor. Lit. Press
GONTI	State United Sci.-Tech. Press
Gosénergoizdat	State Power Engr. Press
Goskhimizdat	State Chem. Press
GOST	All-Union State Standard
GTTI	State Tech. and Theor. Lit. Press
IL	Foreign Lit. Press
ISN (Izd. Sov. Nauk)	Soviet Science Press
Izd. AN SSSR	Acad. Sci. USSR Press
Izd. MGU	Moscow State Univ. Press
LÉIIZhT	Leningrad Power Inst. of Railroad Engineering
LÉT	Leningrad Elec. Engr. School
LÉTI	Leningrad Electrotechnical Inst.
LÉTIIZhT	Leningrad Electrical Engineering Research Inst. of Railroad Engr.
Mashgiz	State Sci.-Tech. Press for Machine Construction Lit.
MÉP	Ministry of Electrotechnical Industry
MÉS	Ministry of Electrical Power Plants
MÉSÉP	Ministry of Electrical Power Plants and the Electrical Industry
MGU	Moscow State Univ.
MKhTi	Moscow Inst. Chem. Tech.
MOPI	Moscow Regional Pedagogical Inst.
MSP	Ministry of Industrial Construction
NII ZVUKSZAPIOI	Scientific Research Inst. of Sound Recording
NIKFI	Sci. Inst. of Modern Motion Picture Photography
ONTI	United Sci.-Tech. Press
OTI	Division of Technical Information
OTN	Div. Tech. Sci.
Stroiizdat	Construction Press
TOÉ	Association of Power Engineers
TsKTI	Central Research Inst. for Boilers and Turbines
TsNIÉL	Central Scientific Research Elec. Engr. Lab.
TsNIÉL-MÉS	Central Scientific Research Elec. Engr. Lab.-Ministry of Electric Power Plants
TsVTI	Central Office of Economic Information
UF	Ural Branch
VIÉSKh	All-Union Inst. of Rural Elec. Power Stations
VNIIM	All-Union Scientific Research Inst. of Meteorology
VNIIZhDT	All-Union Scientific Research Inst. of Railroad Engineering
VTI	All-Union Thermotech. Inst.
VZÉI	All-Union Power Correspondence Inst.

Note: Abbreviations not on this list and not explained in the translation have been transliterated, no further information about their significance being available to us – Publisher.